TRANSFORMING HONG KONG INTO A SMART CITY:

THE ECONOMIC OPPORTUNITY OF DIGITAL TECHNOLOGIES AND SKILLS, AND GOOGLE'S CONTRIBUTION

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αlphaβeta
strategy x economics

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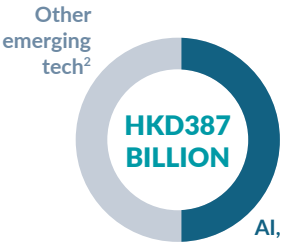
STEPPING INTO HONG KONG'S DIGITAL FUTURE

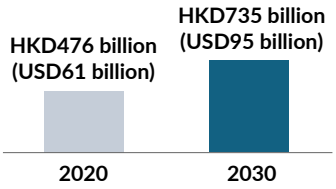
DIGITAL TECHNOLOGIES AND SKILLS CAN UNLOCK SIGNIFICANT ECONOMIC VALUE IN HONG KONG

Digital technologies can bring about HKD387 billion (USD50 billion) worth of economic value by 2030[1]



HALF of this opportunity could come from Artificial Intelligence (AI), Fintech and Big Data applications

Hong Kong already has a large tech-savvy workforce today, but if it were to accelerate its digital skilling efforts, these workers can contribute to 21% of its GDP by 2030



21% of forecasted GDP in 2030

TO FULLY ACHIEVE THIS VALUE, THREE PILLARS OF ACTION ARE NEEDED – AND GOOGLE CONTRIBUTES TO EACH OF THEM

DIGITALLY UPSKILL THE POPULATION

Google's **Grow with Google** initiative provides digital skills training for students, job seekers and business owners in Hong Kong

1

FACILITATE THE ADOPTION OF EMERGING TECH

Google introduces emerging technologies like Augmented Reality (AR) through the **HO JENG AR** mobile application which showcases technologies through interactive activities

2

NURTURE THE LOCAL TECH ECOSYSTEM

Since 2017, Google published a series of research reports, **Smarter Digital City (SDC)**, to explore themes, provide recommendations, and track progress related to Hong Kong's digitisation

3

GOOGLE ALSO SUPPORTS BROADER BENEFITS FOR:

BUSINESSES

Google supports
HKD28.4 BILLION (USD3.7 BILLION)
worth of annual economic benefits to businesses[3]

CONSUMERS

Google supports
HKD16.6 BILLION (USD2.1 BILLION)
worth of annual economic benefits to consumers[3]

SOCIETY

By enabling businesses to unlock new revenue streams and expand their businesses, Google indirectly supports
OVER 14,000 JOBS

1. Economic value refers to GDP increments, productivity gains, cost savings, time savings, increased revenues, increased wages and increased tax collection.
2. This includes the mobile Internet, cloud computing, the Internet of Things, additive manufacturing and advanced robotics.
3. Figures are estimated based on the latest available annual data as at time of research in 2020.

Note: Estimates are based on AlphaBeta analysis using a range of original and third-party sources. See report's Appendix for methodology.

EXECUTIVE SUMMARY

Hong Kong is a global leader in technology and innovation, and the government plans to continue strengthening this edge. Ranked second out of 64 economies in the IMD World Digital Competitiveness Rankings in 2021, Hong Kong is home to one of the world's leading technological ecosystems.[1] This can be seen by the strong growth of its Information and Communications Technology (ICT) sector, which grew by 12 percent between 2013 and 2019 in terms of economic value-add.[2] The government has also given strong support in furthering this development, introducing initiatives such as the **Smart City Blueprint for Hong Kong 2.0** in 2020, which puts forward over 130 initiatives to develop and promote the use of digital technologies.[3]

However, Hong Kong faces several barriers to digital technologies. These barriers include a limited usage of digital technologies among certain businesses, inequity in access to digital tools among the underserved sections of society, and a digital talent gap. The adoption of digital technologies appears to be limited and uneven - a 2019 government survey found that 33 percent of small firms had a web presence, as opposed to 88 percent of large firms.[4] Underserved segments of the population also have limited access to digital tools, with only 53 percent of persons with disabilities owning a smartphone in 2015 and 68.1 percent among the elderly in 2020, far below the territory-wide figure of 92 percent as of 2020.[5] Finally, a recent report revealed that Hong Kong could face a shortage of 746,000 workers by 2030 due to skill gaps, out of which 8.4 percent could be in its technology industry.[6]

The COVID-19 pandemic has amplified the importance of digital technologies in boosting long-term economic resilience. A study has found that, globally, the pandemic has effectively pushed forward the digital revolution by five years.[7] This provides an opportunity for Hong Kong to ride the next digital wave. Digital technologies will be important to boost its economic recovery efforts and enhance the long-term resilience of its economy in the post-pandemic future.

This report finds that, if leveraged fully, digital technologies could create an annual economic value of HKD387 billion (USD50 billion) by 2030.[8] To put this in perspective, this is equivalent to two-thirds of the annual economic value-add of the city's financial services industry today - a significant figure given its status as one of the world's busiest financial services hubs.[9] In addition, beyond the economic benefits that

1. IMD World Competitiveness Center (2021), "IMD World Digital Competitiveness Ranking 2021 results". Available at: https://www.imd.org/centers/world-competitiveness-center/rankings/world-digital-competitiveness/
2. Census and Statistics Department (2020), Hong Kong as an information society 2020. Available at: https://www.statistics.gov.hk/pub/B11100062020AN20B0100.pdf
3. Sources include Innovation and Technology Bureau (2020), Hong Kong Smart City Blueprint 2.0. Available at: https://www.smartcity.gov.hk/modules/custom/custom_global_js_css/assets/files/HKSmartCityBlueprint(ENG)v2.pdf; Examples of initiatives include adopting public cloud services for government departments, promoting technologies for public services such as waste management and transportation, and attracting investment in innovation and technology start-ups.
4. Hong Kong Census and Statistics Department (2019), Report on the Survey on Information Technology Usage and Penetration in the Business Sector (2019 Edition). Available at: https://www.statistics.gov.hk/pub/B11100052019BE19B100.pdf
5. Sources include: Legislative Council of the Hong Kong Special Administrative Region of the People's Republic of China (2016)," Digital inclusion in Hong Kong and the United Kingdom." Available at: https://www.legco.gov.hk/research-publications/english/essentials-1617ise08-digital-inclusion-in-hong-kong-and-the-united-kingdom.htm; Hong Kong SAR Census and Statistics Department (2021), "Thematic Household Survey Report No. 73." Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1130201/att/B11302732021XXXXB0100.pdf
6. Focus (2018), "Hong Kong must use its competitive advantage to close the skills gap." Available at: https://focus.kornferry.com/leadership-and-talent/hong-kong-must-use-its-competitive-advantages-to-close-the-skills-gap/
7. McKinsey & Company (2020), The Next Normal: The recovery will be digital. Available at: https://www.mckinsey.com/~/media/McKinsey/Business Functions/McKinsey Digital/Our Insights/How six companies are using technology and data to transform themselves/The-next-normal-the-recovery-will-be-digital.pdf
8. Economic value refers to GDP increments, productivity gains, cost savings, time savings, increased revenues, increased wages and increased tax collection.
9. Hong Kong Census and Statistics Department. Available at: https://www.censtatd.gov.hk

technologies can bring, it is also important to consider the economic value that digitally skilled people can contribute. While Hong Kong already has a large tech-savvy workforce today, if it were to accelerate the pace of its digital skilling efforts over the next decade, **workers with digital skills can contribute up to a fifth (21 percent) of Hong Kong's gross domestic product (GDP) in 2030.**

The key messages of this report include:

- **Eight key technologies hold transformative potential for businesses and workers in Hong Kong.** These include mobile Internet; cloud computing; big data; Artificial Intelligence (AI); financial technology (Fintech); the Internet of Things (IoT) and remote sensing; advanced robotics; and additive manufacturing. By allowing the creation of new business models and productivity savings, these technologies could create significant economic value for Hong Kong.

- **If fully leveraged, these digital technologies can unlock HKD387 billion (USD50 billion) worth of economic value in Hong Kong by 2030. To gauge the magnitude of the economic impact were these transformative technologies to be fully applied in Hong Kong's economy, this report goes beyond the city's technology sector to estimate the value that could be unlocked in the non-technology sectors.** By generating productivity gains, revenue boosts, cost savings and GDP increments across different sectors, digital technologies can reap up to HKD387 billion (USD50 billion) worth of economic value annually in Hong Kong by 2030. This is a significant figure that is equivalent to two-thirds of the annual economic value-add of the city's financial services industry today.[10]

- **Half of the total digital opportunity will be driven by Fintech, AI and big data - at HKD199 billion (USD25.6 billion).** Across the eight key technologies, Fintech, AI and big data will drive half of Hong Kong's total digital opportunity, pointing to the importance of deploying these applications across the economy. Referring to innovations that aim to compete with traditional methods in the delivery of financial services, Fintech is estimated to bring about significant value for Hong Kong. For example, Fintech firms in Hong Kong are adopting blockchain technology for a growing number of applications such as loan fraud detection.[11] Entailing a set of technologies that enable computers to interact with large data sets to perceive, learn and assist in decision-making to solve problems in ways that are similar to what people do,

10. Hong Kong Census and Statistics Department. Available at: https://www.censtatd.gov.hk Based on AlphaBeta analysis. See Appendix A for details on the methodology.
11. Asia Times (2020), "Blockchain is growing force in HK Fintech sector." Available at: https://asiatimes.com/2020/06/blockchain-is-growing-force-in-hk-fintech-sector/

AI and big data also have numerous applications across various industry sectors in Hong Kong. Examples include AI-enabled concierges in the hospitality industry, natural language processing tools in the professional services industry, AI-enabled health procedures, personalised learning software in the education industry, and predictive maintenance technologies in the infrastructure industry.

- **Upskilling the workforce on digital technologies will be important, as digitally skilled workers can contribute up to a fifth (21 percent) of Hong Kong's GDP by 2030.** Hong Kong already has a large tech-savvy workforce today. Workers with digital skills were estimated to contribute a total of HKD476 billion (USD61 billion), or 18 percent, to Hong Kong's GDP in 2020. While this is already a significant figure, the city can go further. If it were to accelerate the pace of its digital skilling efforts and increase the number of technologically adept workers in the economy, such workers can contribute HKD735 billion (USD95 billion) to Hong Kong's GDP by 2030. This represents 21 percent of Hong Kong's forecasted GDP that year - meaning that for every HKD100 of value added to Hong Kong's economy, HKD21 is potentially generated as a result of work done by a digitally skilled person.

- **Three pillars of action are required for Hong Kong to fully capture its digital opportunity.** While Hong Kong is already making significant progress in some of these areas, there is scope for the city to push further on three key policy areas. These include:

  – First, it is crucial for Hong Kong to ***digitally upskill the population***. The government is already investing in building a pipeline of talent through the **Research Talent Hub** and **STEM Internship Scheme**, which aims to provide industry opportunities to complement Science, Technology, Engineering, and Mathematics (STEM) education. There is also a focus on helping the elderly in Hong Kong to keep abreast of technological developments and skills, through programmes such as the **Enriched ICT Training Programme** for the Elderly by the Office of the Government Chief Information Officer (OGCIO), which aims to encourage the elderly with basic ICT knowledge to adopt technology in their daily living, and even serve as trainers to help others acquire these skills. However, there is still a gap between the demand and supply of technology talents, and other segments of the population continue to have limited access to technologies. There is scope to provide further support for developing digital skills in advanced technologies such as AI and cloud, and to improve access

of ICT tools and services to other underserved segments of the population. To ensure that the current digital skill base of workers is constantly upgraded to adapt to new technologies, it is necessary to continually expand the availability of skilling programmes that address these skill needs. Hong Kong could also consider that underserved segments, such as persons with disabilities, also have targeted programmes that promote digital skills. An example of a targeted policy to provide skilling opportunities to underserved segments is Singapore's **Enable IT Programme**. The programme aims to build an inclusive society and enable persons with disabilities to enhance their abilities and skillsets required for independent living, through workshops on Info-communication and Assistive Technologies (IT/AT).

- Second, Hong Kong should strengthen efforts to ***facilitate the adoption of emerging technologies such as AI and cloud***. The city has launched several initiatives in this area. One of the key initiatives is the **Smart City Blueprint for Hong Kong (Blueprint 2.0)** which aims to enhance and modernise its existing suite of city management measures and services through technological innovations.[12] The government is also working with industry partners to promote digital adoption. For instance, the Hong Kong Productivity Council collaborated with the Hong Kong Computer Society to develop a framework for training courses and promote the adoption of emerging technologies within the IT sector. In addition, the Hong Kong Monetary Authority has also released the **Fintech 2025 Strategy** to enhance Fintech development and adoption in Hong Kong.[13] However, there is still room to further advance digitalisation efforts as other traditional, non-technology sectors lag in digital adoption and businesses continue to face barriers in adopting advanced technologies. Hong Kong could consider creating sector-specific roadmaps for digital adoption. An international best practice is New Zealand's **Industry Transformation Plan**, which aims to lift productivity and growth through a series of enablers that facilitate the adoption of digital technologies in selected sectors, including AI technologies.[14] The government could also explore creating a one-stop platform for businesses to receive tailored support and mentorship, as well as access the funding required to deploy advanced technologies in their companies.

- Third, it is important that Hong Kong continues to ***nurture the local technology and innovation ecosystem***. Having supportive government policies and programmes is key to creating a conducive environment for entrepreneurship and research. A key policy the government is undertaking is the development of innovation clusters in the city. Developed as physical hubs to congregate and create network effects among industry players, build tech talent, and catalyse innovations, such clusters are developed by the Hong Kong Science and Technology Parks Corporation (HKSTP), which was established in 2001.[15] To date, the HKSTP has developed five technology clusters namely, biomedical technology, electronics, green technology, information and communication technology, and material and precision engineering. The government has also provided strong government financial and regulatory support for tech-based start-ups, creating the HKD2 billion (USD258 million) **Innovation and Technology Venture Fund (ITVF)** in 2017. The fund aims to attract more venture capital funds to co-invest in

12. HK Smart City Blueprint (2020), Available at: https://www.smartcity.gov.hk/index.html
13. Hong Kong Monetary Authority (2021), "The HKMA Unveils "Fintech 2025" Strategy". Available at: https://www.hkma.gov.hk/eng/news-and-media/press-releases/2021/06/20210608-4
14. Sources include Ministry of Business, Innovation and Employment (2020), Digital technologies Industry Transformation Plan. Progress update for industry. Available at: https://www.mbie.govt.nz/dmsdocument/11638-digital-technologies-industry-transformation-plan; Ministry of Business, Innovation and Employment (2019), From the Knowledge Wave to the Digital Age. Available at: https://www.mbie.govt.nz/dmsdocument/5866-growing-innovative-industries-in-new-zealand-from-the-knowledge-wave-to-the-digital-age
15. Hong Kong Science & Technology Parks Corporation (2021). Available at: https://www.hkstp.org/

local innovation and technology (I&T) start-ups in Hong Kong. While Hong Kong's start-up ecosystem continues to grow, there is still much room to encourage further innovation, particularly in non-Fintech innovation sectors. According to InvestHK, Fintech companies account for 465 of the city's 3,184 start-ups, as compared with only 104 smart city and 32 biological technology start-ups.[16] One policy to consider would be for Hong Kong to tap on the opportunities presented by the Greater Bay Area (GBA) initiative by leveraging the core competitive advantages of the cities within the GBA and fostering greater regional collaboration efforts to grow the local technology ecosystem.

- **Google has been instrumental to advancing Hong Kong's digital transformation journey and contributes to each of the three pillars.** Google is digitally upskilling the population by launching the CS (Computer Science) First Curriculum initiative – a free computer science curriculum to promote coding education and computer sciences. In addition, Google has trained students, job seekers and business owners in digital skills through various digital skilling programmes under the **Grow with Google** initiative such as **Digital Garage and YouTube Creator Academy**. Also, Google has been promoting the adoption of technologies in Hong Kong. The company launched the **ShareJoy** campaign and created **HO JENG AR** – a mobile application featuring an immersive experience with six augmented reality characters to showcase how creative technologies can do good for individuals, businesses, and for the community. For businesses such as HSBC, a Hong Kong-based international bank, Google Cloud has played a vital role in improving the productivity and efficiency of its call centre business. Google has also been nurturing the local technology and innovation ecosystem through projects such as its Smarter Digital City research programme which provides guidance annually since 2017 for policymakers, businesses and other stakeholders in seizing opportunities in the growing digital economy.

- **Google also delivers broader economic benefits to businesses, consumers and the wider society in Hong Kong through its products and services.** Google's products and services are estimated to bring about total annual business and consumer benefits **worth HKD28.4 billion (USD3.7 billion)** and **HKD16.6 billion (USD2.1 billion)**, respectively.[17] Combined, the total value that Google brings, at HKD45 billion (USD5.8 billion), is equivalent to the total GDP contribution from Hong Kong's utilities sector today.[18] The products that these benefits were estimated for include: Google Search, Google Ads, Google AdSense, Google Play, Google Maps, YouTube, Google Drive, and Google Docs, Sheets and Photos. For businesses, such benefits come in the form of increased revenue through better customer outreach and access to new markets, as well as improved productivity through time savings. Consumers, on the other hand, experience greater convenience, access to information, and more avenues for learning and skills development. Beyond its economic contributions to businesses and individuals, Google also supports benefits to the wider society in Hong Kong. By enabling businesses to unlock new revenue streams and expand their businesses through the use of Google Ads, AdSense, and YouTube, Google indirectly supports **over 14,000** jobs in Hong Kong.[19] Furthermore, Google also delivers intangible benefits through its programmes, such as extending digital skilling opportunities to underserved communities and promoting safe Internet use in Hong Kong.

16. KPMG (2020), Transforming Hong Kong through entrepreneurship".
Available at: https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2020/12/transforming-hong-kong-through-entrepreneurship.pdf
17. The Google applications and services included in the analysis of business benefits include Google Search and Ads, AdSense, Google Maps, and Google Play. The Google applications and services included in the analysis of consumer benefits include Google Search, Google Maps, Google Play, Drive, Photos, Docs, and Sheets. The estimates are of Google's annual economic impact based on the latest available data (i.e., in 2019, or where available, more recent data spanning a 12-month period between 2019 and 2020).
18. Hong Kong Census and Statistics Department. Available at: https://www.censtatd.gov.hk Based on AlphaBeta analysis. See Appendix C for details on the methodology.
19. Jobs supported refer to new jobs that may have been created through a business' use of Google's platforms, as well as ongoing employment of jobs that previously existed.

SIZING THE PRIZE — THE ECONOMIC OPPORTUNITY OF DIGITAL TECHNOLOGIES AND SKILLS IN HONG KONG

Digital technologies can drive significant economic benefits for government, businesses and individuals in Hong Kong. Applying these technologies in traditional, non-technology sectors can create up to HKD387 billion (USD50 billion) worth of economic value annually in Hong Kong's economy by 2030. This is equivalent to two-thirds of the annual economic value-add of the city's financial services sector - a significant number given Hong Kong's status as one of the world's busiest financial services hubs.

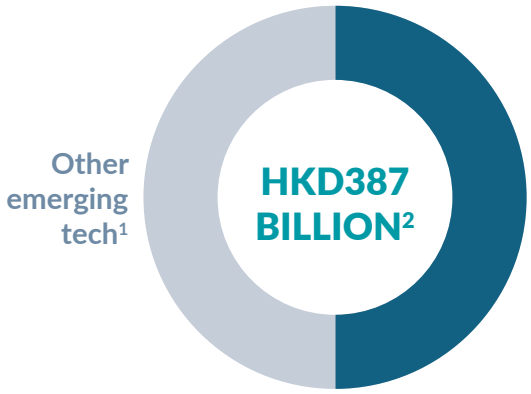
Beyond the economic benefits that technologies drive, it is also important to consider the economic value that digitally skilled people can bring. While Hong Kong already has a large tech-savvy workforce today, if it were to accelerate the pace of its digital skilling efforts over the next decade, workers with digital skills can contribute up to a fifth (21 percent) of Hong Kong's GDP in 2030. This means that for every HKD100 of value added to Hong Kong's economy, HKD21 will be potentially generated as a result of work done by a digitally skilled person.

"SIZING THE PRIZE"

THE ECONOMIC VALUE OF DIGITAL TECHNOLOGIES AND SKILLS

DIGITAL TECHNOLOGIES AND SKILLS CAN UNLOCK SIGNIFICANT ECONOMIC VALUE IN HONG KONG

Digital technologies can bring about HKD387 billion (USD50 billion) worth of economic value by 2030



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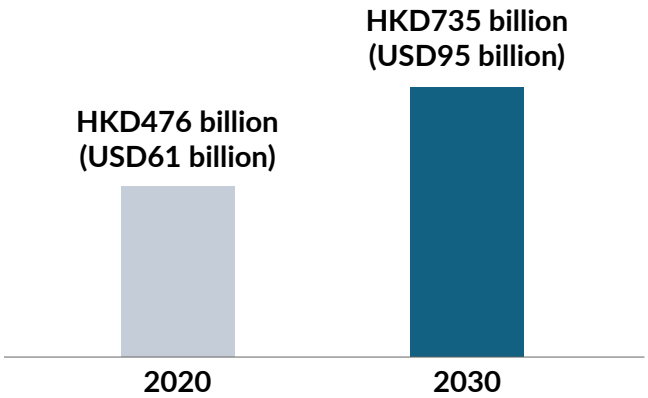


21% of forecasted GDP in 2030

1. This includes the mobile Internet, cloud computing, the Internet of Things, additive manufacturing and advanced robotics.
2. Economic value refers to GDP increments, productivity gains, cost savings, time savings, increased revenues, increased wages and increased tax collection.
Note: Estimates are based on AlphaBeta analysis using a range of original and third-party sources. See report's Appendix for methodology.

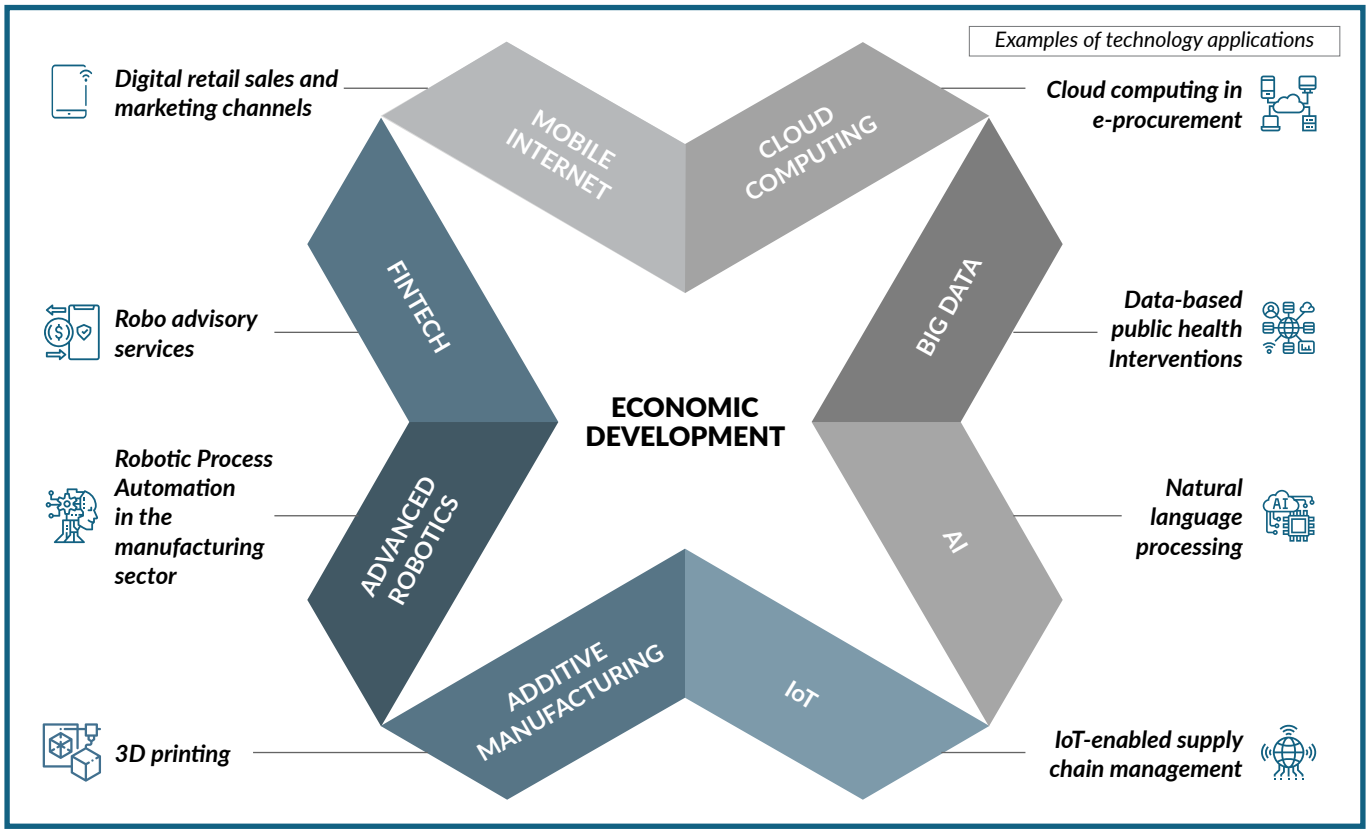
1.1 DIGITAL TECHNOLOGIES CAN UNLOCK UP TO HKD387 BILLION (USD50 BILLION) WORTH OF ECONOMIC VALUE IN 2030

Digital technologies can unlock significant economic value in Hong Kong, and **eight key technologies hold transformative potential for the city** (Exhibit 1). Across these eight technologies, 41 applications were identified across ten industry sectors. To assess the economic potential of digital transformation in Hong Kong, the economic value of each technology application was estimated under a scenario of full adoption in 2030 (Exhibit 2).

It is estimated that **digital technologies have the potential to create an annual economic value of HKD387 billion (USD50 billion) in Hong Kong by 2030.**[20] This value is equivalent to two-thirds of the annual economic value-add of Hong Kong's financial services industry today - a significant figure given its status as one of the world's busiest financial hubs.[21]

EXHIBIT 1:

CURRENT RESEARCH REFLECTS EIGHT TRANSFORMATIVE TECHNOLOGIES WITH STRONG ECONOMIC POTENTIAL



20. These estimates do not represent GDP or market size (revenue), but rather economic impact, including GDP increments, productivity gains, cost savings, time savings, increased revenues, increased wages and increased tax collection.
21. Hong Kong Census and Statistics Department. Available at: https://www.censtatd.gov.hk Based on AlphaBeta analysis. See Appendix A for details on the methodology.

EXHIBIT 2:

41 DIGITAL TECHNOLOGY APPLICATIONS ACROSS 10 SECTORS WERE IDENTIFIED TO SIZE HONG KONG'S ECONOMIC OPPORTUNITY FROM DIGITAL TRANSFORMATION

Agriculture & food

- Precision farming technologies
- IoT-enabled supply chain management
- Food safety technologies

Consumer, retail & hospitality

- Digital retail sales and marketing channels
- IoT-enabled inventory management
- Automation & AI customer service in hotels
- Data analytics on travel patterns
- Online F&B delivery channels

Education & training

- E-career centres and digital jobs platforms
- Personalised learning
- Online retraining programmes

Financial services

- Big data analytics
- Reg tech
- Digital banking services
- Smart contracts
- Robo advisory services

Government

- Cloud computing
- E-procurement
- Geographic Info. System enabled tax collection
- Data analytics for government transfer payments

Health

- Remote patient monitoring
- Telehealth applications
- Data-based public health Interventions
- Detection of counterfeit pharmaceutical drugs
- Smart medical devices
- Electronic medical records

Infrastructure

- Smart grids
- Predictive maintenance technologies
- Smart buildings

Manufacturing

- Big data analytics
- Additive manufacturing
- IoT-enabled supply chain management
- Automation & robotics

Professional Services

- Cloud storage
- Data analytics and visualisation
- Natural language processing
- Automated billing and multi-currency conversion

Transport services

- Smart roads
- Smart ports
- Autonomous vehicles
- Geospatial services

Key technologies:

- *Mobile Internet*
- *Advanced robotics*
- *Cloud computing*
- *AI*
- *Fintech*
- *Additive manufacturing*
- *Big Data*
- *IoT*

Half of this opportunity could come from Fintech, AI and big data applications, pointing to their importance for Hong Kong's future digital economy. Combined, the economic value of these applications would amount to HKD199 billion (USD25.6 billion), accounting for 51 percent of Hong Kong's total digital opportunity.[22] Of this value, HKD104 billion (USD13.4 billion) is estimated to be derived from Fintech applications, and the remaining HKD95 billion (USD12.2 billion) is estimated to arise from AI and big data applications.[23] Exhibit 3 shows a breakdown of the economic value estimated from the full application of each technology in Hong Kong.

The key opportunities posed by digital technologies are as follows:

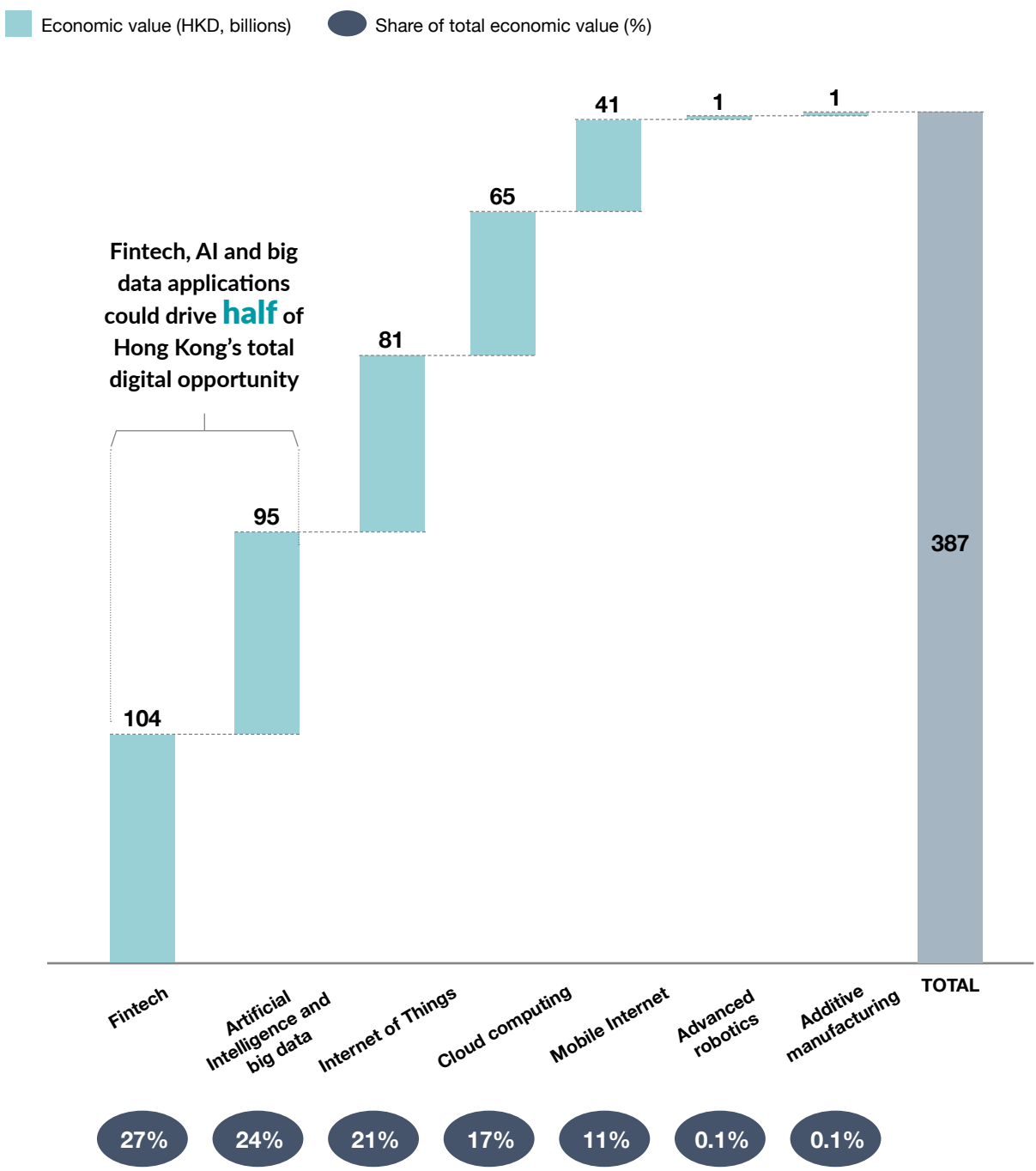
- **Fintech.** Referring to innovations that aim to compete with traditional methods in the delivery of financial services, Fintech is estimated to bring about significant value for Hong Kong. This is unsurprising given that Hong Kong is one of the world's most prominent financial services hubs. For example, Fintech firms in Hong Kong are adopting blockchain technology for a growing number of applications such as loan fraud detection.[24] One such firm is CryptoBLK, which jointly launched a motor insurance platform that uses blockchain to minimise fraud in insurance claims, with the Hong Kong Federation of Insurers (HKFI).[25] CryptoBlk is also working with partners such as Microsoft and R3, a provider of enterprise technology and services, to explore applications across different industries.[26] In addition, virtual banks, financial institutions with no physical branches, such as ZA Bank, WeLab Bank and Mox Bank have enhanced the banking experience for customers and are gaining traction in Hong Kong. According to the Hong Kong Monetary Authority, all eight virtual banks had 840,000 customers and HKD21 billion in deposits, as of June 2021.[27] Fintech is often applied in conjunction with other technologies like AI and big data. One such combined application is robo-advisors, which provide financial advice or investment management services based on algorithms. Magnum Research, for instance, launched an AI-powered portfolio that has stock-picking and asset allocation capabilities. Taking into consideration portfolio risks, such as individual stock concentration and sector risk profiles, the AI-powered portfolio uses machine learning to learn different patterns and attempt to predict future returns.[28] Fintech's benefits go beyond the financial services sector. By allowing for cashless payments, Fintech has also been responsible for driving greater growth in other sectors (e.g., consumer, retail and hospitality).

22. Based on AlphaBeta analysis. See Appendix A for details on the methodology.
23. Based on AlphaBeta analysis. See Appendix A for details on the methodology.
24. Asia Times (2020), "Blockchain is growing force in HK Fintech sector." Available at: https://asiatimes.com/2020/06/blockchain-is-growing-force-in-hk-fintech-sector/
25. Insurance Business Asia (2018), "Hong Kong to use blockchain versus motor insurance fraud." Available at: https://www.insurancebusinessmag.com/asia/news/breaking-news/hong-kong-to-use-blockchain-versus-motor-insurance-fraud-119640.aspx
26. Invest Hong Kong (2021), "InvestHK x FTAHK Fintech Spotlight Series - CryptoBLK". Available at: https://www.youtube.com/watch?v=vs-TTYfrjkE
27. South China Morning Post (2021), "Top Hong Kong virtual banks seek new frontier in second year of operations, eye marriage with wealth management services". Available at: https://www.scmp.com/business/banking-finance/article/3144179/top-hong-kong-virtual-banks-seek-new-frontier-second-year
28. Fund Selector Asia (2019), "Will robots start launching their own funds?" Available at: https://fundselectorasia.com/will-robos-start-launching-their-own-funds/

EXHIBIT 3:

DIGITAL TECHNOLOGIES COULD UNLOCK HKD387 BILLION (USD50 BILLION) WORTH OF ECONOMIC IMPACT IN HONG KONG BY 2030

POTENTIAL ANNUAL ECONOMIC VALUE[1] FROM DIGITAL TECHNOLOGIES



1. These estimates do not represent GDP or market size (revenue), but rather economic impact, including GDP increments, productivity gains, cost savings, time savings, increased revenues, increased wages and increased tax collection.

Note: Numbers may not sum due to rounding.

SOURCE: AlphaBeta analysis

- **Artificial Intelligence (AI) and big data.** Referring to the simulation of human intelligence processes by machines and computer systems, AI entails a set of technologies that enable computers to perceive, learn, reason and assist in decision-making to solve problems in ways that are similar to what people do.[29] AI is often used with big data. AI-powered applications become more effective, the more data they are given. Data is meaningless without the capabilities to analyse it - by automating and enhancing data preparation, predictive modelling and other complex analytical tasks that would otherwise be labour-intensive and time-consuming, AI is often applied to big data sets to provide meaningful insights. AI and big data have numerous applications across various industry sectors in Hong Kong. Examples include AI-enabled concierges in the hospitality industry, natural language processing tools in the professional services industry, AI-enabled health procedures, personalised learning software in the education industry, and predictive maintenance technologies in the infrastructure industry. Hong Kong has a number of emerging AI technology companies such as Accosys. This company focuses on providing AI-enabled concierge services for organisations such as shopping malls.[30] Users can use the services for tasks such as locating directions to shops on their phones and making reservations.

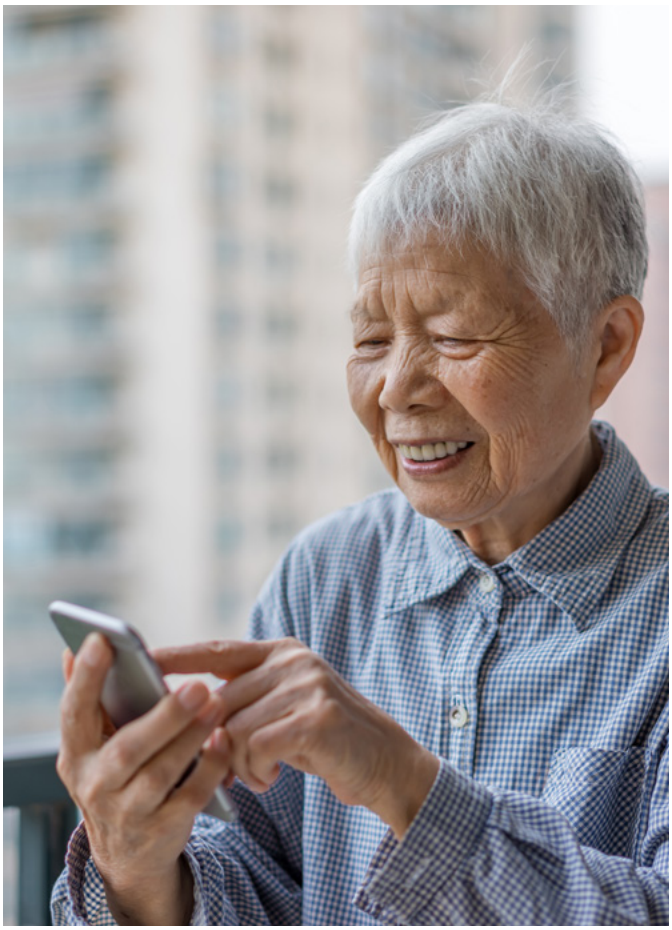
- **Internet of Things (IoT).** IoT systems relate to the network of physical objects ("things") that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet. These systems can monitor and manage the performance of connected objects and machines.[31] IoT has a number of applications across sectors with significant economic potential in Hong Kong. For example, Megasoft Limited, an IoT applications company, developed the Drug Refill Management System (DRMS) for the Hospital Authority (HA) in Hong Kong in 2017 by using IoT technology.[32] The system has significantly reduced the waiting time for patients during collection of medications from hospitals and enhanced the accuracy of the process. Hospitals are also using devices such as Smart Medical Cabinets to manage inventory and ensure that the right medicines are dispersed using radio-frequency identification (RFID) tools.[33] IoT has also been widely used to help tackle the pandemic. Retailers and businesses in Hong Kong deployed IoT-enabled thermal detection solutions to detect abnormal body temperatures of people entering offices, stores and restaurants. The systems raised alerts and uploaded records via 4G networks.[34]

- **Cloud computing.** Referring to the delivery of information technology (IT) resources over the Internet, cloud computing technologies allow individuals and entities to access technology services such as enhanced computing power, data storage and management tools on an as-needed basis. Buying, owning, and maintaining physical data centres and servers can be cost-prohibitive, particularly for micro, small, and medium-sized enterprises (MSMEs). In addition, public cloud hosting boosts productivity by providing tailored productivity tools, enabling improved security, and making resources available on an on-demand basis. Cloud computing has been widely applied in Hong Kong, with proven benefits. The Hong Kong government, for example, launched the Government Cloud Infrastructure Services (GCIS) in 2020, providing a secure, reliable and scalable IT infrastructure equipped with agile application development tools.[35] The GCIS, as a central hybrid

29. Microsoft (2018), The future computed. Available at: https://blogs.microsoft.com/wp-content/uploads/2018/02/The-Future-Computed_2.8.18.pdf
30. The University of Hong Kong (2016), "Artificial Intelligence at Your Service". Available at: https://www.ke.hku.hk/story/innovation/artificial-intelligence-at-your-service
31. MGI (2019), The rise of Digital Challengers – How digitisation can become the next growth engine for central and eastern Europe. Available at: https://digitalchallengers.mckinsey.com/files/McKinsey%20CEE%20report_The%20Rise%20of%20Digital%20Challengers.pdf
32. Yim (2021), "Healthtech Innovations: IoT First-Mover Eyes GBA Market." Available at: https://research.hktdc.com/en/article/Nzg1NjE0NjQy
33. RTHK (2021), "The Kowloon East Network introduces an intelligent system to assist in dispensing medicines and managing drug inventories". Available at: https://news.rthk.hk/rthk/ch/component/k2/1611701-20210922.htm
34. Yick (2021), "IoT in Hong Kong: new use cases helping make COVID-19 recovery safer." Available at: https://www.orange-business.com/en/blogs/iot-hong-kong-new-use-cases-helping-make-covid-19-recovery-safer
35. Sources include: Office of the Government Chief Information Officer (2021), Government Cloud Infrastructure Services. Available at: https://www.ogcio.gov.hk/en/our_work/infrastructure/e_government/gcis/index.html; CIOTech Asia (2020), "Hong Kong will benefit from 5G and Cloud." Available at: https://ciotechasia.com/hong-kong-will-benefit-from-5g-and-cloud/

cloud platform, enables government departments to expedite system development and upgrade system capacity more flexibly and at a lower cost. It also provides 24-hour monitoring and support services to ensure effective and secure delivery of e-government services.

- **Mobile Internet.** The rapid rise of the smartphone and associated increase in mobile Internet penetration rates have accelerated the growth of Internet services worldwide. The mobile Internet in Hong Kong has already driven the adoption of new business models such as the app economy, over-the-top (OTT) services and mobile-commerce (or "m-commerce"). Businesses have experienced the benefits from tapping into the mobile Internet. Many retail and food and beverage (F&B) businesses in Hong Kong have turned to online platforms such as e-commerce marketplaces and mobile applications to digitise their offerings for customers. For example, the share of home delivery for full-service restaurants increased from 2.4 percent in 2013 to 3.2 percent in 2019.[36] This growth was further accelerated by the pandemic. According to Deliveroo, one of the leading delivery platforms in Hong Kong, the average number of food delivery orders made per user each month increased from 2.5 pre-pandemic to four times in March 2020.[37] In the retail industry, the productivity gains from marketing and selling goods through digital channels are estimated to range from six to 15 percent – these arise as a result of being able to reduce resource requirements, harness inventory efficiencies, and cut real estate costs (e.g., rental of store space).[38] However, there are several mobile Internet-enabled applications that have yet to see full adoption in the city. These include the use of mobile telehealth applications in the health sector.[39]



- **Advanced robotics.** While simple robots have increasingly been a staple of factory floors in mature economies like Hong Kong, the advent of advanced robotics has allowed for an expanding range of tasks that robots can perform. Compared with conventional robots, advanced robots have superior perception, integrability, adaptability, and mobility.[40] These improvements permit faster setup, reconfiguration, as well as more efficient and stable operations. For instance, in the manufacturing sector, advanced robotics can increase productivity and flexibility on both the factory floor and in the supply chain, and enable producers to rapidly adjust to changing customer needs. An example is Geek+, a global company specialising in advanced robotics for smart logistics

36. Euromonitor (2020), "Coronavirus Pandemic to Boost Food Delivery Industry in the Greater Bay Area." Available at: https://blog.euromonitor.com/coronavirus-pandemic-to-boost-food-delivery-industry-in-the-greater-bay-area/
37. Euromonitor (2020), "Coronavirus Pandemic to Boost Food Delivery Industry in the Greater Bay Area." Available at: https://blog.euromonitor.com/coronavirus-pandemic-to-boost-food-delivery-industry-in-the-greater-bay-area/
38. McKinsey Global Institute (2013), Disruptive technologies: Advances that will transform life, business, and the global economy. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies
39. There have been some trials in hospitals but mobile telehealth applications are not widely adopted. HKTDC Research (2020), "The Post-Covid New Normal: The Rise of Telemedicine". Available at: https://research.hktdc.com/en/article/NTkzOTE0MDg4 and South China Morning Post (2020), "Telemedicine offers solutions to Hong Kong patients unwilling to visit hospitals for check-ups amid coronavirus crisis". Available at: https://www.scmp.com/news/hong-kong/health-environment/article/3078507/telemedicine-offers-solutions-hong-kong-patients?module=perpetual_scroll&pgtype=article&campaign=3078507
40. Boston Consulting Group (2019), Advanced robotics in the factory of the future. Available at: https://www.bcg.com/publications/2019/advanced-robotics-factory-future

with offices in Hong Kong. Geek+ recently launched RoboShuttle RS5, a robot designed to pick and operate on narrow aisles, reach new heights and thereby increase warehouse storage capacity by 2.5 times and save up to 50 percent of warehouse space while maintaining high efficiency.[41] Other use cases of advanced robotics in Hong Kong are in the health sector. A patent is granted for a powered orthotic device that supports movement of a user's arm and fingers in order to increase functionality of patients suffering from neurological disorders and upper-limb paralysis.[42] Furthermore, rapid advancements in technology are starting to allow for robotic surgeries to be conducted safely and remotely. For example, in 2019, the Chinese University of Hong Kong (CUHK) completed clinical trials of "single-port" robotic arms for surgeries.[43]

- **Additive manufacturing.** This relates to technologies that build 3D objects by adding layer upon layer of material. There is a range of potential benefits, such as the ability to handle complex, low-volume components where rapid turnaround is critical.[44] The Hong Kong Productivity Council (HKPC), for instance, has successfully developed a new formula for advanced materials in micro-powder injection moulding. The newly developed micro-powder is used in the Powder Injection Moulding (PIM) manufacturing process, allowing a low-toxic production method and can produce parts of high precision and complex geometry.[45] The PIM manufacturing process has been applied for the production of automobile parts, computers, consumer electronics and jewellery.

41. Sources include: Geek+ (2021), Tote-to-Person Picking. Available at: https://source.www.geekplus.com/product/roboshuttle; SHD Logistics (2021), "Geek+ provides world's first double-deep-tote-picking robot." Available at: https://www.shdlogistics.com/robotics-automation/geek-provides-worlds-first-double-deep-tote-picking-robot
42. Business Wire (2021), "Myomo, Inc. Announces Granting of Patents in China and Hong Kong." Available at: https://www.businesswire.com/news/home/20210907005795/en/Myomo-Inc.-Announces-Granting-of-Patents-in-China-and-Hong-Kong
43. South China Morning Post (2019), "Hong Kong's Chinese University successfully completes clinical trials of 'single-port' robotic arm for surgery – and patients find system a cut above as well." Available at: https://www.scmp.com/news/hong-kong/health-environment/article/2181892/hong-kongs-chinese-university-successfully
44. Sharp (2019), "Is additive manufacturing the right choice for your electronic assembly?" JJS Manufacturing Blog. Available at: https://blog.jjsmanufacturing.com/additive-manufacturing-electronic-assembly
45. Sources include: Hong Kong Productivity Council (n.d.). New Formulae for Micro-Powder Injection Moulding Materials Paves Way for Green Production of High Precision Parts. Available at: https://www.hkpc.org/en/our-services/additive-manufacturing/latest-information/powder-green; Hong Kong Productivity Council (n.d.). Metallic and Ceramic Powder Injection Moulding (PIM) Technology. Available at: https://www.hkpc.org/en/our-services/additive-manufacturing/metallic-and-ceramic-powder-injection-moulding-pim-technology

1.2 DIGITALLY SKILLED WORKERS CAN CONTRIBUTE TO A FIFTH OF HONG KONG'S GDP BY 2030

Beyond the benefits that technologies can bring, it is also important to consider the economic value that digitally skilled people can bring to Hong Kong's economy.

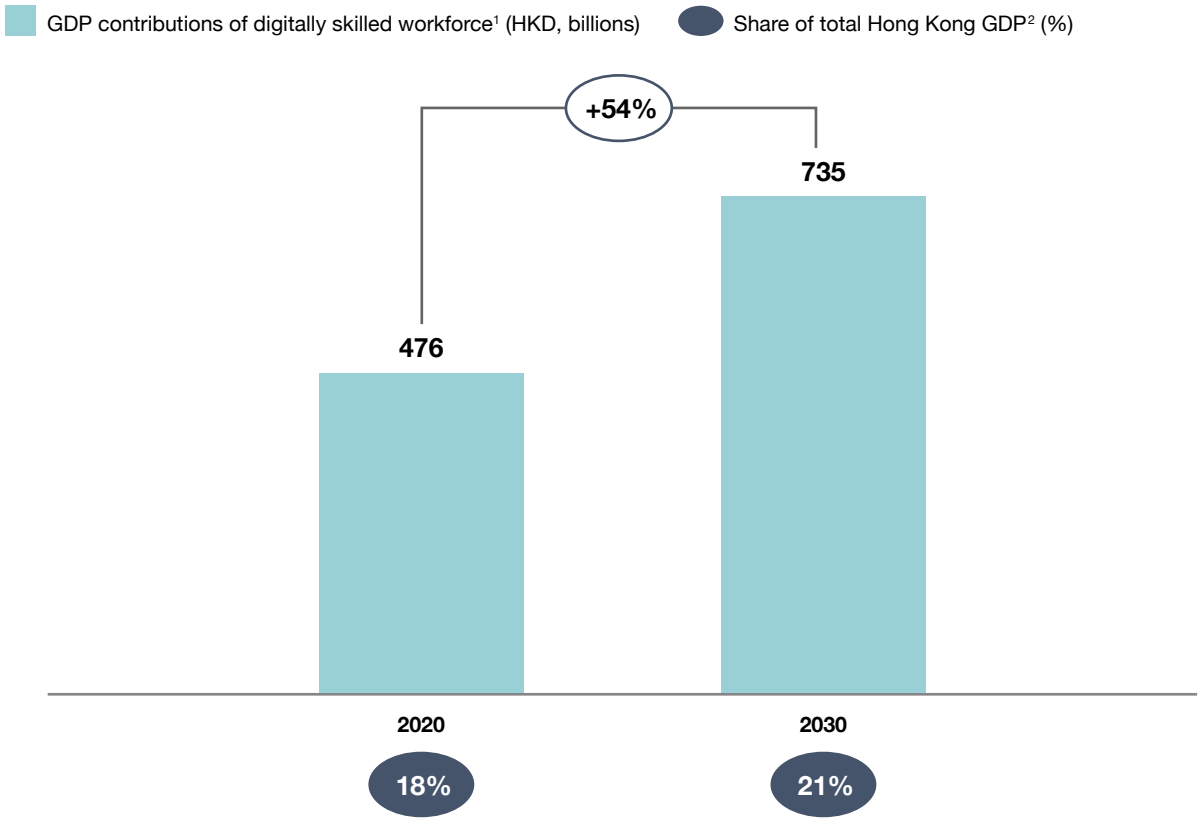
Hong Kong already has a large digitally skilled workforce today which contributes to 18 percent of its GDP annually. Today, workers with digital skills in the city are estimated to contribute HKD476 billion (USD61 billion), or 18 percent of Hong Kong's GDP (Exhibit 4). This value takes into account the annual GDP contributions of both workers in the technology sector, and workers in non-technology sectors that need to apply digital skills in their jobs. Indeed, contrary to the conventional notion that much of the GDP contribution by digitally skilled workers is likely to come from the technology sector, a majority 85 percent of this value today is in fact derived from its non-technology sectors, such as the financial services, government services, education and training, and health sectors.

However, Hong Kong can go even further on digitally skilling its workforce. By 2030, if Hong Kong accelerates its current digital skilling rate to match the performance of global leaders such as Sweden, Ireland and Finland, the annual GDP contribution of digitally skilled workers could grow by 54 percent to reach HKD735 billion (USD95 billion) in 2030 – which is equivalent to 21 percent of its forecasted GDP (Exhibit 4). This means that for every HKD100 of value added to Hong Kong's economy, HKD21 will be potentially generated as a result of work done by a digitally skilled person.

EXHIBIT 4:

IF HONG KONG ACCELERATES ITS PACE OF DIGITAL SKILLING, ANNUAL GDP CONTRIBUTIONS FROM ITS DIGITALLY SKILLED WORKFORCE COULD GROW BY 54% FROM HKD476 BILLION (USD61 BILLION) TODAY TO HKD735 BILLION (USD95 BILLION) IN 2030

ESTIMATED VALUE OF DIGITAL SKILLS IN HONG KONG, 2020 AND 2030



1. The value of digital skills from these workers are estimated based on their full GDP contributions.
2. Based on total Hong Kong GDP in the year that the digital skills value was estimated for.
Note: Figures may not sum due to rounding.
SOURCE: AlphaBeta analysis

CAPTURING THE PRIZE — THREE PILLARS OF ACTION

To fully capture the digital opportunity, three pillars of action will be required in Hong Kong: 1) Digitally upskill the population; 2) Facilitate the adoption of emerging tech like AI and cloud; and 3) Nurture the local technology and innovation ecosystem.

The Hong Kong Government has already made significant progress within all three pillars. To digitally upskill the population, the Innovation and Technology Commission launched the STEM Internship Scheme to encourage students to gain innovation and technology-related work experience during their studies and foster their interest in pursuing a tech career after graduation. To facilitate the adoption of emerging tech like AI and cloud, the Hong Kong Government published the Smart City Blueprint for Hong Kong (Blueprint 2.0) which puts forward over 130 initiatives to enhance and expand its existing city management measures and services in applying innovation and technology. To nurture the local technology and innovation ecosystem, the Hong Kong Science and Technology Parks Corporation (HKSTP) was established to create a vibrant ecosystem that connects industry players, build tech talent, and catalyse innovations. Cyberport, an innovative digital community with over 1,650 start-ups and technology companies, was also launched to spearhead the growth of major technologies as well as facilitate the transformation of Hong Kong into a smart city. Furthermore, the Hong Kong Government has set up a HKD2 billion (USD258 million) Innovation and Technology Venture Fund (ITVF) to attract more venture capital funds to co-invest in local innovation and technology start-ups in Hong Kong.

"CAPTURING THE PRIZE"
THREE PILLARS OF ACTION

Three pillars of action are required to fully unlock the digital opportunity

1. Digitally upskill the population
2. Facilitate the adoption of emerging tech like AI and cloud
3. Nurture the local technology and innovation ecosystem

Significant effort has already been made in the following areas

- Providing industry opportunities to complement STEM education
- Broadening access to digital skilling opportunities for seniors
- Broadening access to digital skilling opportunities for employees to upgrade their skillsets
- Developing a roadmap to accelerate the adoption of new technologies
- Partnering with industry to promote adoption
- Creating innovation clusters to facilitate the development of new technology applications
- Providing strong government financial and regulatory support for tech-based start-ups

However, there are areas in which Hong Kong can further strengthen its approach

- Develop more digital skilling programmes to train current digital workers in advanced digital skillsets such as AI and cloud
- Improve access of ICT tools and services to the underserved segments
- Create sector-specific roadmaps for AI adoption
- Address barriers to the adoption of advanced digital technologies for businesses
- Foster regional collaboration efforts to grow the local technology ecosystem

For Hong Kong to fully adopt digital technologies and expedite the digital-led recovery from the impacts of the COVID-19 pandemic, the city could consider adopting international best practices to enhance its existing initiatives. Despite efforts to increase the emphasis on STEM education, there is still a gap between the demand and supply of technology talents. Hong Kong could develop more digital skilling programmes to train current digital workers in advanced digital skillsets such as AI. Besides implementing economy-wide initiatives to encourage digital adoption among businesses, the government could consider placing greater emphasis on providing companies in non-technology sectors with tailored support to adopt digital technologies. While Hong Kong's start-up ecosystem continues to grow, there is still much room to encourage further innovation. Hong Kong should leverage the core competitive advantages of the cities within the Greater Bay Area (GBA) and foster greater regional collaboration efforts to grow the local technology ecosystem.

2.1 PILLAR 1: DIGITALLY UPSKILL THE POPULATION

To reap the benefits of digital technologies, it is critical that the Hong Kong workforce possesses the right skills to apply digital technologies in their jobs. At the same time, the seeds for a future generation of adaptable and digitally skilled workforce must be planted early to ensure a healthy digital talent pipeline. Hong Kong is already building digital talent through the following actions:

- **Providing industry opportunities to complement Science, Technology, Engineering, and Mathematics (STEM) education.** To encourage STEM students to gain technology-related work experience during their studies and to foster their interest in pursuing a tech career after graduation, the Innovation and Technology Commission launched the **STEM Internship Scheme** in June 2020.[46] Under this pilot scheme, the University Grants Committee (UGC) provides an allowance for undergraduates and postgraduates taking university full-time STEM programmes to enrol in short-term internships.[47] The internship positions under the scheme, with most of them being offered by MSMEs, cover various areas, such as coding, web design, big data analytics, machine learning, robotics, electronic engineering, digital marketing, biotechnology and food technology. With the pilot's success, the STEM Internship Scheme was extended for another cycle.[48] Furthermore, the government has launched the Research Talent Hub for ITF projects (RTH-ITF) in 2020 to provide funding support for companies to hire talents for research and development (R&D) projects funded by the Innovation and Technology Fund (ITF).[49]

- **Broadening access to digital skilling opportunities for seniors.** To help the elderly in Hong Kong to keep abreast of the latest developments in the digital society, the Office of the Government

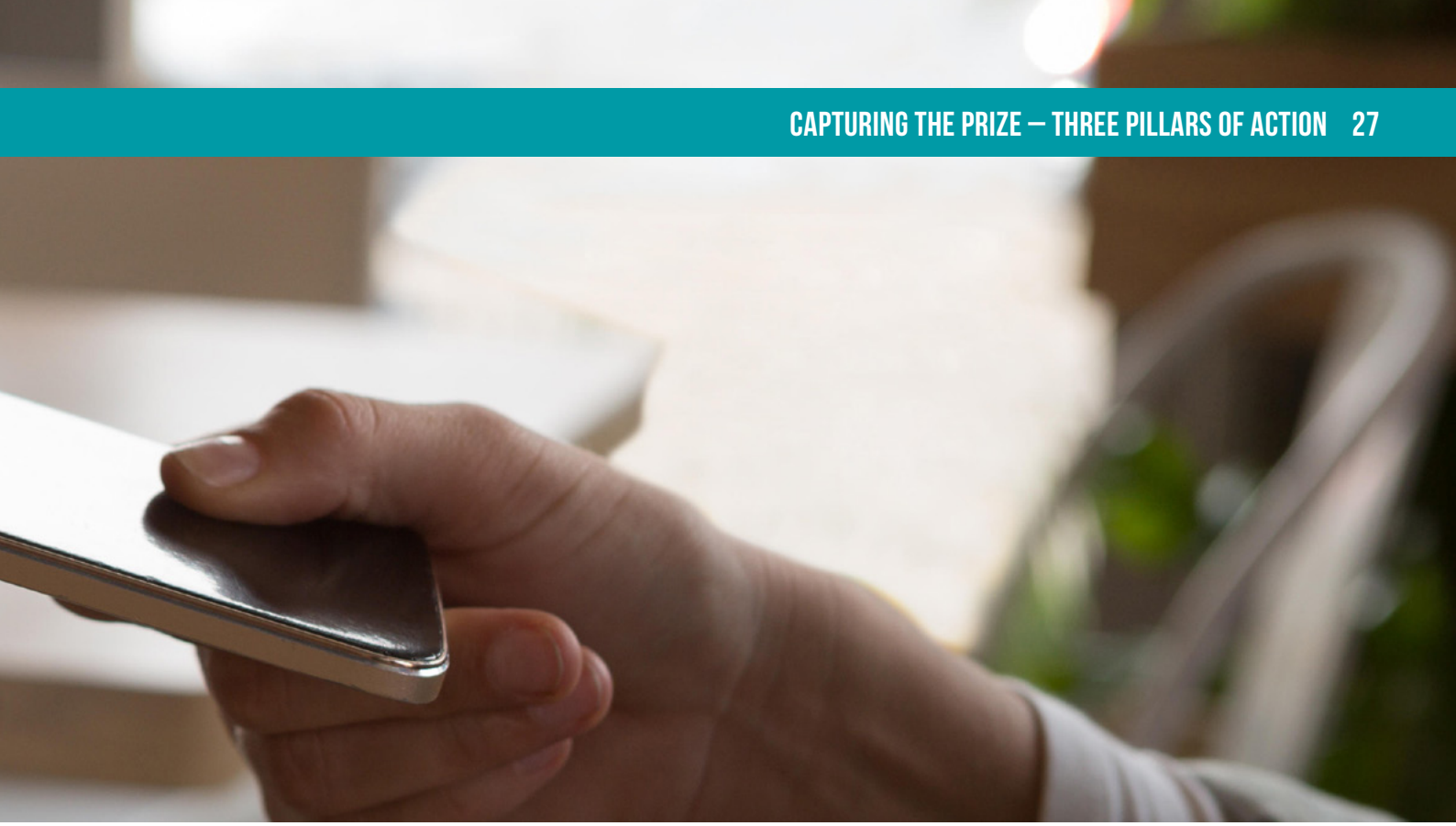
46. Innovation and Technology Commission (2020), "STEM Internship Scheme".
Available at: https://www.itf.gov.hk/en/funding-programmes/nurturing-talent/stem-internship-scheme/
47. Innovation and Technology Commission (2020), "STEM Internship Scheme".
Available at: https://www.itf.gov.hk/en/funding-programmes/nurturing-talent/stem-internship-scheme/
48. Legislative Council (2021), Legislative Council Panel on Public Service: Efforts in Attracting Young People to Join the Government.
Available at: https://www.legco.gov.hk/yr20-21/english/panels/ps/papers/ps20210217cb4-499-3-e.pdf
49. Innovation and Technology Fund (2021), "Research Talent Hub for ITF projects (RTH-ITF)".
Available at: https://www.itf.gov.hk/en/funding-programmes/nurturing-talent/research-talent-hub/research-talent-hub-for-itf-projects-rth-itf-/index.html

Chief Information Officer (OGCIO) launched a two-year **Enriched ICT Training Programme for the Elderly** initiative between 2019 and 2021.[50] The programme aims to encourage the elderly with basic ICT knowledge to adopt technology in their daily living, and even serve as trainers to help others acquire these skills.[51] Furthermore, the OGCIO also launched a web-based learning platform to help the elderly acquire digital skills remotely at their own pace.[52]

- **Broadening access to digital skilling opportunities for employees to upgrade their skillsets.** To support local enterprises in training their staff in advanced technologies, the Vocational Training Council launched the **Reindustrialisation and Technology Training Programme** (RTTP) which provides up to HKD500,000 (USD64,475) in funding support for public and tailor-made courses.[53] While some courses are open to the public for registration, there are also other courses designed based on the needs of particular enterprises.

Despite efforts to increase the emphasis on STEM education and careers, the supply of technology talents continues to fall short of demand.[54] A study revealed that over half of businesses (53 percent) cited that the availability of local AI talent is insufficient, and 39 percent of businesses faced challenges in recruiting AI talent.[55] Hong Kong could go further to enhance its reskilling efforts for the current workforce, as well as enhance the quality of its digital skills education. Furthermore, there are certain segments of the population with limited access to technologies. For instance, 53 percent of persons with disabilities own a smartphone, far below the territory-wide average of 92 percent.[56] While the OGCIO has supported the development of ICT-based assistive tools and applications for persons with disabilities, more could be done to develop training programmes to serve other

50. OGCIO (2019), "Two-year Enriched ICT Training Programme for the Elderly 2019-2021". Available at: https://www.ogcio.gov.hk/en/our_work/community/ict_programmes_for_elderly/2018-19-training/
51. Hong Kong Government (2020), "Innovation and Technology". Available at: https://www.gov.hk/en/about/abouthk/factsheets/docs/technology.pdf
52. Hong Kong Government (2020), "Innovation and Technology". Available at: https://www.gov.hk/en/about/abouthk/factsheets/docs/technology.pdf
53. The Government of the Hong Kong Special Administrative Region (2020), "Enhanced arrangements for Reindustrialisation and Technology Training Programme, Patent Application Grant and Public Sector Trial Scheme announced". Available at: https://www.info.gov.hk/gia/general/202003/27/P2020032700271.htm?fontSize=1
54. HKTDC Research (2021), "Hong Kong Start-Up Survey: Ecosystem Overview". Available at: https://research.hktdc.com/en/article/NjYwMTUyNDYy
55. Google (2020), "How can Hong Kong become a Smarter Digital City?". Available at: https://forhongkong.withgoogle.com/intl/en/acceleration-digital-transformation/
56. Sources include: Legislative Council of the Hong Kong Special Administrative Region of the People's Republic of China (2016)," Digital inclusion in Hong Kong and the United Kingdom." Available at: https://www.legco.gov.hk/research-publications/english/essentials-1617ise08-digital-inclusion-in-hong-kong-and-the-united-kingdom.htm ; Hong Kong SAR Census and Statistics Department (2021), "Thematic Household Survey Report No. 73." Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1130201/att/B11302732021XXXXB0100.pdf



underserved communities.[57] Hong Kong could consider the following measures:

- **Develop more digital skilling programmes to train current digital workers in advanced digital skillsets such as AI and cloud.** To ensure that the current digital skill base of workers is constantly upgraded to adopt new technologies, it is necessary to continually expand the availability of digital skilling programmes. It is imperative for the Hong Kong Government to develop structured skilling programmes and professional training courses to upskill workers in these areas. The relevant agencies could conduct a diagnostic of the skill gaps across sectors to identify new skilling programmes for the general population. Hong Kong could also facilitate stronger industry-academia partnerships in order to develop new expertise in these fields. The city could reference best practice approaches internationally. For instance, in Australia, through close collaboration with cloud service providers, the Royal Melbourne Institute of Technology (RMIT) and La Trobe University in Australia developed a series of successful cloud computing courses for full-time and part-time learners.[58]

- **Improve access of ICT tools and services to the underserved segments.** An example of a targeted policy to provide skilling opportunities to underserved segments is Singapore's **Enable IT Programme**. This programme aims to use Info-communication and Assistive Technologies (IT/AT) to enable persons with disabilities to develop the skills required for independent living.[59] This programme includes an IT/AT Loan Library to loan devices to individuals, Voluntary Welfare Organisations (VWOs) and Special Education (SPED) schools, as well as workshops to educate persons with disabilities on the relevant tools and applications. The programme is estimated to have helped around 3,000 beneficiaries between 2017 and 2021.[60]

57. OGCIO (2011), "Development of Assistive Technologies for Persons with Disabilities". Available at: https://www.ogcio.gov.hk/en/our_work/community/past_di_initiatives/disabilities/
58. Sources include: La Trobe University (2018), "First Cloud Technology degree". Available at: https://www.latrobe.edu.au/news/articles/2018/release/first-cloud-technology-degree; RMIT, "Cloud & Software Solutions". Available at: https://online.rmit.edu.au/software-development/cloud-software-solutions
59. Ministry of Communications and Information (2017), "Enable IT Programme." Available at: https://www.mci.gov.sg/wps2017/modules/articles/overview/enable-it-programme
60. Open Gov Asia (2017), "Singapore government announces slew of initiatives to build digital society and sets up central office for coordination." Available at: https://opengovasia.com/singapore-government-announces-slew-of-initiatives-to-build-digital-society-and-sets-up-central-office-for-coordination/

2.2 PILLAR 2: FACILITATE THE ADOPTION OF EMERGING TECH LIKE AI AND CLOUD

Seen as one of the global leaders in technology and innovation, Hong Kong has been making significant strides in accelerating the city's digital development. In the IMD World Digital Competitiveness Ranking 2020 that measures the capacity and readiness of economies to adopt and explore digital technologies for economic and social transformation, Hong Kong was ranked fifth among 63 economies.[61] Its high ranking was mainly attributed to the strong growth of its ICT industry that grew by 12 percent between 2013 and 2019, as well as the large share of high-tech exports as a percentage of manufactured exports.[62] However, when it comes to the level of preparedness to utilise emerging digital technologies such as robotics, big data and analytics, businesses in the city lag when compared to their counterparts across Asia. In a 2017 study conducted to benchmark the AI-preparedness of economies based on the ability of their companies and workforces to capitalise on AI, Hong Kong ranked seventh out of eight Asian markets.[63] Another study reflected that Hong Kong-based companies tend to invest more in basic technologies such as digital marketing and customer relationship management but have fewer investments in advanced technological applications like big data and machine learning.[64]

To encourage the adoption of advanced technologies such as AI and cloud computing, Hong Kong has several initiatives:

- **Developing a roadmap to accelerate the adoption of new technologies.** During the COVID-19 pandemic, the Hong Kong Government published the **Smart City Blueprint for Hong Kong (Blueprint 2.0)** which puts forward over 130 initiatives to enhance and expand its existing city management measures and services in applying innovation and technology.[65] These initiatives are categorised under six smart areas, namely "Smart Mobility", "Smart Living", "Smart Environment", "Smart People", "Smart Government" and "Smart Economy". In "Smart Living", for instance, one of the initiatives involves exploring the use of blockchain technology to enhance the traceability of pharmaceutical products, identify sectoral and seasonal patterns in the supply of medicines, and facilitate efficient and effective recalls of medicines. The blueprint also highlights programmes that encourage local enterprises and organisations to adopt technological services or solutions to enhance operational efficiency. One such example is the **Technology Voucher Programme** (TVP) classified under "Smart Economy". Through TVP, local enterprises can receive a cumulative funding of up to HKD600,000 (USD77,200) for technology consultancy, auditing and technological solutions such as big data and cloud-based analytics solutions, AR technologies systems, and real-time manufacturing tracking systems.[66]

- **Partnering with industry to promote adoption.** The Hong Kong Productivity Council (HKPC), a statutory organisation that aims to promote the adoption of advanced digital technologies to enhance Hong Kong's productivity, spearheads

61. IMD World Competitiveness Center (2020), "IMD World Digital Competitiveness Ranking 2020 results". Available at: https://www.imd.org/wcc/world-competitiveness-center-rankings/world-digital-competitiveness-rankings-2020/
62. Sources include Census and Statistics Department (2020), Hong Kong as an Information Society 2020. Available at: https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1110006&scode=590
63. Asia Business Council (2017), Artificial Intelligence in Asia: Preparedness and Resilience. Available at: http://www.asiabusinesscouncil.org/docs/AI_briefing.pdf
64. Google & Nielsen (2017), Smarter digital city. Available at: https://services.google.com/fh/files/misc/2017_google_nielsen_smarter_digital_city_whitepaper.pdf
65. HK Smart City Blueprint (2020), Available at: https://www.smartcity.gov.hk/index.html
66. Innovation and Technology Fund (2020), "Technology Voucher Programme (TVP)". Available at: https://www.itf.gov.hk/en/funding-programmes/facilitating-technology/tvp/

Photo Source: https://www.dexigner.com/news/33453

efforts to promote the adoption of emerging technologies among businesses.[67] In February 2021, the HKPC signed a memorandum of understanding with the Hong Kong Computer Society (HKCS), the largest industry-level non-profit organisation that focuses on developing Hong Kong's IT sector, to collaborate on developing skills, education programs, and promote the adoption of emerging technologies among HKCS' members. These technologies include 5th generation mobile network (5G), AI, cloud computing, and IoT.[68]

To enable the Hong Kong industry to fully reap the benefits of AI, there is scope for the city to consider the following measures:

- **Create sector-specific roadmaps for AI adoption.** Besides implementing economy-wide initiatives to encourage digital adoption among businesses, the government could consider placing greater emphasis on providing companies in traditional, non-technology sectors with tailored support to adopt digital technologies, particularly AI. While the government has developed roadmaps to enhance Fintech development and promote regulatory technology (Regtech) adoption within the financial services sector such as the Hong Kong Monetary Authority's **Fintech 2025 Strategy**,[69] many other non-technology sectors lack specific plans to accelerate digital adoption, including AI technologies. An international best practice worth considering in Hong Kong is New Zealand's

67. Hong Kong Productivity Council (HKPC) (2020), About us. Available at: https://www.hkpc.org/en/about-us/background
68. Taiwan News (2021), "Hong Kong Productivity Council and Hong Kong Computer Society Sign Pact to Enhance the Adoption of Emerging Technologies in Hong Kong," Available at: https://www.taiwannews.com.tw/en/news/4133415
69. Hong Kong Monetary Authority (2020), "The HKMA developed a two-year roadmap to promote Regtech adoption," Available at: https://www.hkma.gov.hk/eng/news-and-media/press-releases/2020/11/20201103-3/ and Hong Kong Monetary Authority (2021), "The HKMA Unveils "Fintech 2025" Strategy". Available at: https://www.hkma.gov.hk/eng/news-and-media/press-releases/2021/06/20210608-4

Industry Strategy, which aims to lift productivity and growth through a series of enablers that facilitate the adoption of digital technologies in selected sectors (Box 1). As part of this initiative, the New Zealand government is working with industry to create a national AI strategy to promote trust in and application of AI technologies within specific sectors of the economy.[70]

- **Address barriers to the adoption of advanced digital technologies.** The government could explore creating a one-stop platform for businesses to access crucial tailored support, such as mentorship and funding, to facilitate the adoption of advanced technologies in their companies. Finland offers an international best practice in this regard. Recent research has shown that due to the robust ecosystem, over 31 percent of Finnish companies, with more than five employees, utilise AI daily.[71] A key player in the ecosystem is **Finland's Artificial Intelligence Accelerator** (FAIA), an organisation dedicated to helping firms deploy AI, launched by the Ministry of Economic Affairs and Employment.[72] Unlike typical start-up accelerators that support companies providing AI solutions, this programme is designed to help non-tech companies utilise AI in their operations (see Box 2).

70. AI Forum New Zealand (2021), "Introducing Aotearoa's proposed AI cornerstones." Available at: https://aiforum.org.nz/2021/04/29/introducing-aotearoas-proposed-ai-cornerstones/
71. SILO AI (2020), "State of AI in Finland: public sector is the pacemaker, and more than 1200 companies are using artificial intelligence on a daily basis". Available at: https://silo.ai/state-of-ai-in-finland/#:~:text=Finnish%20public%20sector%20is%20a,tripled%20from%202017%20(0.9%25).
72. Finland's Artificial Intelligence Accelerator (2020), "Market Research". Available at: https://faia.fi/market-research/

BOX 1.
NEW ZEALAND'S DIGITAL TECHNOLOGY INDUSTRY TRANSFORMATION PLANS TRANSFORM TRADITIONAL INDUSTRIES

In June 2019, the Ministry of Business, Innovation and Employment (MBIE) partnered with the New Zealand Tech Alliance (NZTech), a group of technology industry associations, to launch the **Industry Strategy** which aims to educate and encourage businesses in a range of sectors to adopt technologies, innovate and enhance productivity. At the core of this strategy are the **Industry Transformation Plans** (ITPs), which identify opportunities to lift productivity and growth in key sectors which include construction, food and beverage, agriculture, digital technology and forestry and wood processing.[73]

In one of the priority sectors, agriculture, a cross-agency taskforce has been formed in the government with the mandate to design and coordinate an Agritech ITP. The plan first identified obstacles and constraints that have held back growth in the Agritech industry. Subsequently, an action plan was drawn up to create multiple workstreams that addressed each challenge. One of the workstreams includes connecting local Agritech firms with global leaders in Agritech, like the Netherlands which is home to multiple agriculture innovation hubs. To fully exploit Agritech research ideas into finished products and services, the taskforce partnered with the country's innovation agency, Callaghan Innovation, to accelerate commercialisation and spinouts from research institute intellectual property (IP) through on-farm technology prototyping.[74]

73. Sources include: Ministry of Business, Innovation and Employment (2020), Digital technologies Industry Transformation Plan. Progress update for industry. Available at: https://www.mbie.govt.nz/dmsdocument/11638-digital-technologies-industry-transformation-plan; Ministry of Business, Innovation and Employment (2019), From the Knowledge Wave to the Digital Age. Available at: https://www.mbie.govt.nz/dmsdocument/5866-growing-innovative-industries-in-new-zealand-from-the-knowledge-wave-to-the-digital-age

74. Ministry of Business, Innovation and Employment (2020), Agritech Industry Transformation Plan. Available at: https://www.mbie.govt.nz/dmsdocument/11572-growing-innovative-industries-in-new-zealand-agritech-industry-transformation-plan-july-2020-pdf

BOX 2.
FINLAND'S ARTIFICIAL INTELLIGENCE ACCELERATOR DEDICATED TO SUPPORTING FIRMS IN DEPLOYING AI SOLUTIONS

Within two years of the launch of the city's **National AI Strategy** in 2017, the number of companies applying AI in Finland almost tripled.[75] Of the 1,250 Finnish companies utilising AI in their daily operations in 2019, roughly 60 percent had developed their own AI solutions. A separate study of SMEs carried out in 2018 also found that eight percent of the city's SMEs were already using or testing AI, while 24 percent were considering to implement AI technology in their businesses.[76] To support SMEs that lack the resources to invest in their own AI development, the Ministry of Economic Affairs and Employment partnered with the industry associations, Technology Industries of Finland and Silo AI, to establish **Finland's AI Accelerator** (FAIA).

Under this six-month accelerator programme, companies can pilot the use of AI without having to invest heavily in AI projects. During the initial phase, companies have the opportunity to work with service providers, AI start-ups and academia to develop and deploy AI applications in their processes and deliverables.[77] In addition, FAIA publishes publicly available playbooks on the **Basics of AI, Chatbots** and **Continuous AI Development** based on learnings from every programme cycle to share with other companies embarking on their AI adoption process. The organisation also publishes an annual report on The State of AI in Finland which offers a comprehensive outlook of the Finnish AI market while showcasing various AI solutions that have been put into production to serve as use cases.[78]

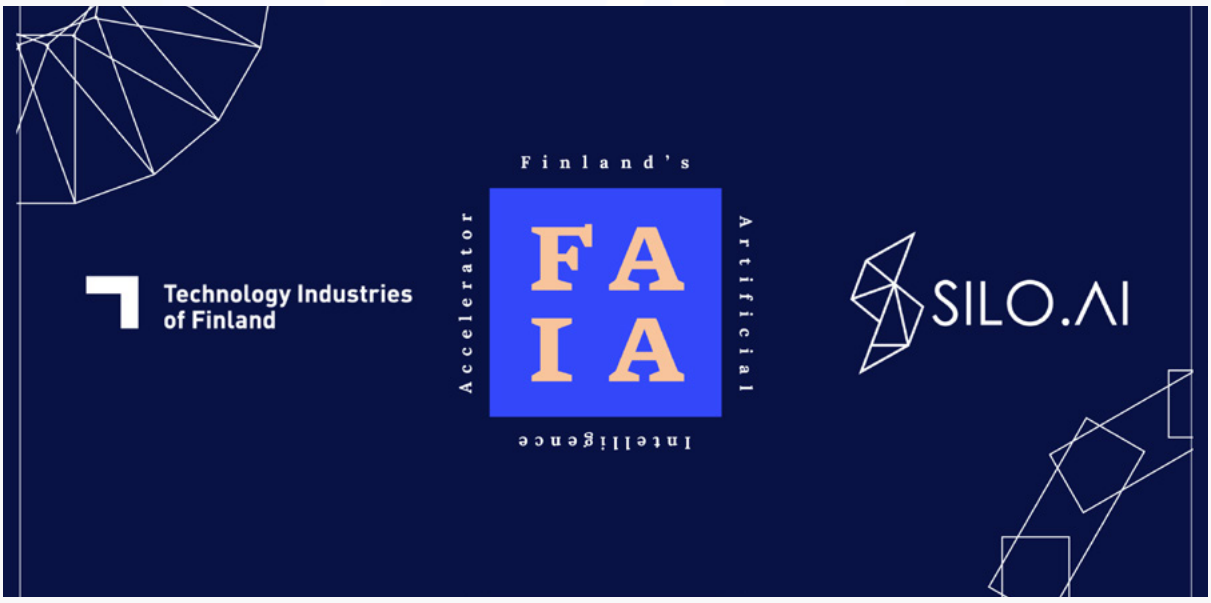


Photo Source: https://silo.ai/faia-publishes-the-fourth-ai-landscape-the-finnish-ai-ecosystem-is-growing/

75. SILO AI (2020), "State of AI in Finland: public sector is the pacemaker, and more than 1200 companies are using artificial intelligence on a daily basis". Available at: https://silo.ai/state-of-ai-in-finland/#:~:text=Finnish%20public%20sector%20is%20a,tripled%20from%202017%20(0.9%25).
76. Ministry of Economic Affairs and Employment (2019), Leading the way into the age of artificial intelligence. Available at: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161688/41_19_Leading%20the%20way%20into%20the%20age%20of%20artificial%20intelligence.pdf?sequence=4
77. McKinsey & Company (2020), "Unlocking growth in small and medium-size enterprises". Available at: https://www.mckinsey.com/industries/public-and-social-sector/our-insights/unlocking-growth-in-small-and-medium-size-enterprises
78. Finland's Artificial Intelligence Accelerator (2020), "Market Research". Available at: https://faia.fi/market-research/

2.3 PILLAR 3: NURTURE THE LOCAL TECHNOLOGY AND INNOVATION ECOSYSTEM

The COVID-19 pandemic has highlighted how entrepreneurship and innovation promote economic resilience amongst companies. A study in Hong Kong reflected that 34 percent of entrepreneurs experienced a rise in demand for their products, compared to 19 percent of corporates which tended to be less innovative.[79] There is also increased investment into entrepreneurial ideas, with start-ups in the city clinching 680 venture capital deals in 2020, the highest number on record in Hong Kong since 2014. In particular, the total capital invested into incubation programmes by the Hong Kong Government has nearly doubled from HKD4 million (above USD500,000) in 2019 to over HKD8 million (above USD1 million) in 2020. Examples of successful Hong Kong start-ups include education technology (EdTech) firm, Preface, and insurance technology company, OneDegree. In September 2021, Preface, which focuses on customisable coding courses, has secured Series A funding from Sunlink Holdings (H.K.) Limited and reported a year-on-year revenue growth of 500 percent over the past 12 months.[80] OneDegree was founded in 2016 and provides digital insurance products for pets, homes and businesses. In 2021, the company raised USD28 million in a new round of funding, bringing its total fundraising to over USD70 million.[81] Having supportive government policies and programmes is key to creating a conducive environment for promoting entrepreneurship and innovation, with the Hong Kong Government having provided valuable support in the following areas:

- **Creating innovation clusters to facilitate the development of new technology applications.** In 2001, the Hong Kong Science and Technology Parks Corporation (HKSTP) was established to create a vibrant innovation and technology ecosystem that connects industry players, builds tech talent, and catalyses innovations. HKSTP has developed five technology clusters namely, biomedical technology, electronics, green technology, information and communication technology, and material and precision engineering. The green technology cluster, for example, features a living laboratory, highly customised labs and technical centres, such as the Autonomous Vehicle Road Testing Hub, that enable businesses to develop, test and commercialise their green solutions. One example is Ecoinno, a local green material company that produces sustainable packaging out of plant fibre.[82] By leveraging a variety of overseas networks and talent pool, Ecoinno managed to successfully partner with major Asian airlines to serve in-flight meals in fully compostable dishware. Another example is Cypress Bio-Tech which developed a mosquito repellent fabric softener. Cypress's patented formula ensures that the mosquito repellent ingredients are evenly distributed on clothing and users only require one-tenth of the portion of regular mosquito repellents to achieve the same results.[83] As of January 2021, HKSTP had

79. KPMG (2020), Transforming Hong Kong through entrepreneurship".
Available at: https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2020/12/transforming-hong-kong-through-entrepreneurship.pdf
80. Yahoo (2021), "Hong Kong-based EdTech Company Preface Sees 500% YoY Surge in Revenue, Overcoming Impact of Pandemic".
Available at: https://finance.yahoo.com/news/hong-kong-based-edtech-company-130000715.html
81. Bloomberg (2021), "Hong Kong's OneDegree Raises $28 Million in New Round of Funding".
Available at: https://www.bloomberg.com/news/articles/2021-08-30/hong-kong-s-onedegree-raises-28-million-in-new-round-of-funding
82. HKSTP (2020), "Jumpstarter Global Pitch Competition Winner has raised nearly HKD50 million from Alibaba Entrepreneur Fund".
Available at: https://www.hkstp.org/en/our-partner-companies/our-partners-stories/success-stories/ecoinno/
83. HKSTP (2020), "Fending Off Insect-Linked Diseases To Enable Healthy Living".
Available at: https://www.hkstp.org/our-partner-companies/our-partners-stories/success-stories/cypress-bio-tech/

nurtured 1,000 technology companies and facilitated over 90 private and public sector partnerships.[84] The Hong Kong Government has also established Cyberport, an innovative digital community with over 1,650 start-ups and technology companies, to spearhead the growth of major technologies such as Fintech, cybersecurity and blockchain as well as facilitate the transformation of Hong Kong into a smart city.[85] Cyberport offers a full range of entrepreneurial support including an incubation programme, go-to-market support, investor matching and fund support, alignment with regulators, and collaboration with financial institutions. The digital technology ecosystem is also home to multinational companies such as Microsoft, Lenovo and IBM. Meanwhile, the Hong Kong Trade Development Council (HKTDC) has been actively creating partnership opportunities between international companies and local tech-based companies in the fields of medical technology (MedTech), EdTech and smart city technology.[86]

- **Providing strong government financial and regulatory support for tech-based start-ups.** In 2017, the Hong Kong Government has set up a HKD2 billion (USD258 million) **Innovation and Technology Venture Fund** (ITVF) to attract more venture capital funds to co-invest in local innovation and technology (I&T) start-ups in Hong Kong.[87] While there were a significant number of angel investors providing seed to pre-Series A funding during that period, the funding sources available to I&T start-ups were relatively inadequate, particularly from Series A to B stages.[88] The ITVF thus aimed to match up to HKD400 million of investments with a co-investment partner in order to further stimulate investment from the private sector.[89] To encourage the experimentation of new technologies, the Hong Kong Monetary Authority has launched the Fintech Supervisory Sandbox (FSS) which enables the Fintech sector to test technology and run pilots without having to achieve full compliance.[90] As a result, developers can gather real-life data and user feedback, which can then be used to make refinements to the product or service before launching.

While Hong Kong's start-up ecosystem continues to grow, there is still much room to encourage further innovation, particularly in non-Fintech innovation sectors. According to InvestHK, Fintech companies account for 465 of the city's 3,184 start-ups, as compared with only 104 smart city and 32 biological

84. HKSTP (2021), "Making an Impact". Available at: https://www.hkstp.org/en/about-us/who-we-are/
85. Cyberport (2021), "Hong Kong: The FinTech Hub of Asia". Available at: https://www.cyberport.hk/en/about_cyberport/about_overview/cyberport-fintech and Cyberport (2021), "About Cyberport". Available at: https://www.cyberport.hk/en/about_cyberport/about_overview
86. HKTDC (2020), "Hong Kong: Technology in Action". Available at: https://hkmb.hktdc.com/en/hong-kong-technology-in-action
87. Innovation and Technology Fund (2017), "Innovation and Technology Venture Fund (ITVF)". Available at: https://www.itf.gov.hk/en/funding-programmes/supporting-start-ups/itvf/index.html
88. Innovation and Technology Fund (2016), Item for Finance Committee. Available at: https://www.itf.gov.hk/filemanager/en/content_43/FCR-2016-17-67.pdf
89. Innovation and Technology Fund (2017), "Innovation and Technology Venture Fund (ITVF)". Available at: https://www.itf.gov.hk/en/funding-programmes/supporting-start-ups/itvf/index.html
90. Hong Kong Monetary Authority (2016), "Fintech Supervisory Sandbox (FSS)". Available at: https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/fintech/fintech-supervisory-sandbox-fss/

technology start-ups.[91] Thus, Hong Kong could consider the following actions to further nurture its local technology and innovation ecosystem:

- **Foster regional collaboration efforts to grow the local technology ecosystem.** In a recent Global Startup Ecosystem Report 2020 by Startup Genome, Hong Kong was ranked 29th behind other Asian cities such as Beijing (4th), Tokyo (15th), Singapore (17th) and Seoul (20th).[92] For the city to stimulate the growth of the local technology system, Hong Kong can consider tapping on the opportunities presented by the landmark **Greater Bay Area** (GBA) initiative. Through the initiative, nine cities in Guangdong's Pearl River Delta, including Hong Kong and Macau, are brought together to transform the region into an innovation and technology hub.[93] The goal is to develop a powerhouse with the economic heft that is comparable to the world's leading bay areas in San Francisco, New York and Tokyo. To further promote innovation and create growth opportunities, Hong Kong should leverage the core competitive advantages of the cities within GBA and foster greater regional collaboration efforts to grow the local technology ecosystem. For instance, Shenzhen's high-tech manufacturing and technology innovation capabilities have made itself China's leading centre for technology and innovation. Shenzhen is set to invest more than RMB700 billion (USD108 billion) in high-tech R&D from 2021 to 2025 and its digital economy is targeted to account for more than 31 percent of its GDP by 2025.[94] One way forward for Hong Kong will be to establish pilot programmes, such as the Hong Kong-Shenzhen Innovation and Technology Park, aimed at facilitating better movement of people, goods, services and money within the region.[95] Box 3 highlights the importance of regional collaboration hubs.

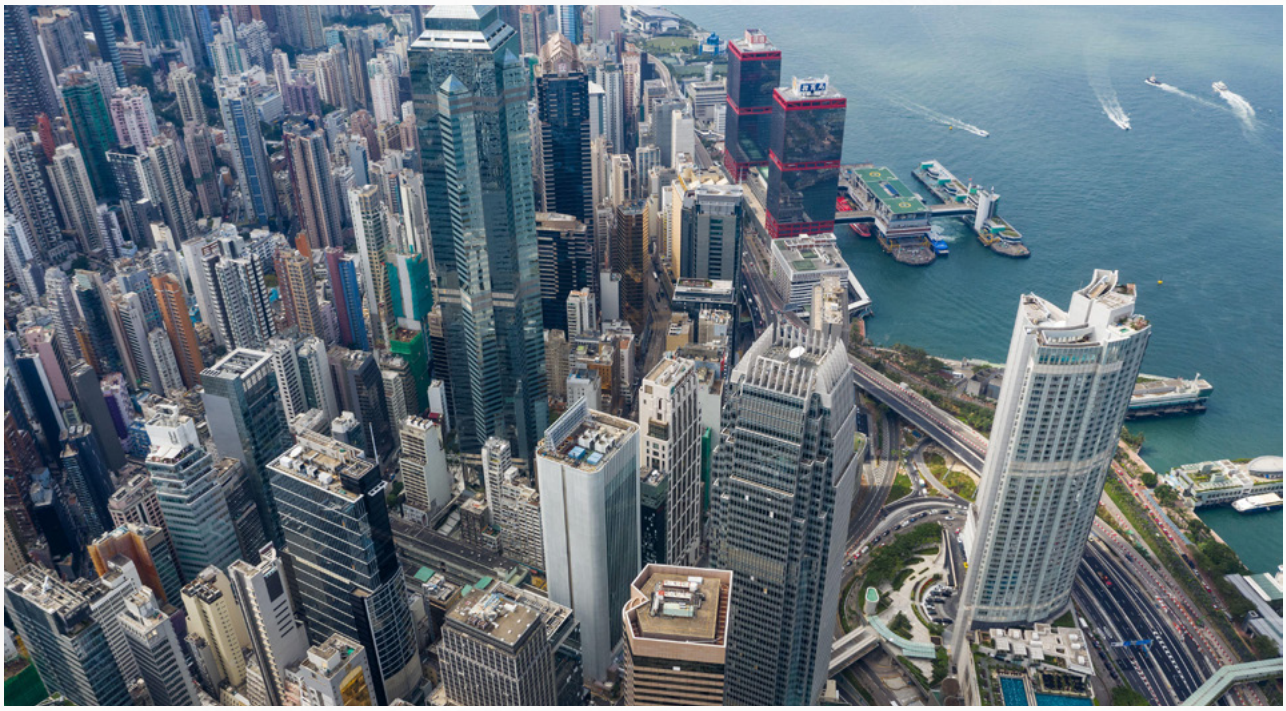
91. KPMG (2020), Transforming Hong Kong through entrepreneurship". Available at: https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2020/12/transforming-hong-kong-through-entrepreneurship.pdf
92. HKTDC Research (2021), "Hong Kong Start-Up Survey: Ecosystem Overview". Available at: https://research.hktdc.com/en/article/NjYwMTUyNDYy
93. KPMG (2018), A lens on the Greater Bay Area. Available at: https://assets.kpmg/content/dam/kpmg/cn/pdf/en/2018/04/a-lens-on-the-greater-bay-area.pdf
94. South China Morning Post (2021), "China's tech hub Shenzhen to invest US$108 billion in R&D over 5 years". Available at: https://www.scmp.com/news/china/science/article/3132651/chinas-tech-hub-shenzhen-invest-us108-billion-rd-over-5-years
95. The Hong Kong-Shenzhen Innovation and Technology Park serves as a bridge to the Greater Bay Area, Mainland China and resources across the border. The Park aims to leverage the competitive advantages of both Hong Kong and Shenzhen in innovation and technology and attract R&D expertise from around the world. Sources include HKSTP (2021), "Hong Kong-Shenzhen Innovation and Technology Park". Available at: https://www.hkstp.org/about-us/our-footprint/hsitp/

BOX 3.
IMPORTANCE OF REGIONAL COLLABORATIONS

Countries that prioritise regional collaboration efforts or hubs have shown that such initiatives can drive the technology and innovation ecosystem. There are several major regional collaboration hubs globally including San Francisco Bay Area, Greater Tokyo Area and New York Metropolitan Area. For instance, the San Francisco Bay Area is home to around 800,000 jobs related to business services, information technology, education and knowledge creation, with start-ups contributing the most to job growth within the region and 60 percent of establishments.[96] In addition, the San Francisco Bay Area generated an economic output exceeding USD720 billion in 2015, with economic growth outpacing the USA as a whole. In these regional collaboration hubs, the key factors that have led to the growth of their technology and innovation ecosystems include 1) Facilitating the flow of people (e.g., professionals in the STEM industries) and ideas in an integrated market; 2) Attracting R&D investment to the region; 3) Positioning themselves as a data hub for their region and; 4) Cultivating start-ups and entrepreneurs.

An emerging collaboration hub in Asia is the Guangdong-Hong Kong-Macao Greater Bay Area (GBA). The GBA, conceptualised in 2016, aims to enhance collaboration and reap potential synergies between cities within the region through projects that focus on areas such as:[97]

- **Promoting inter-region collaboration within academic research.** For example, the development of the **Mainland-Hong Kong**



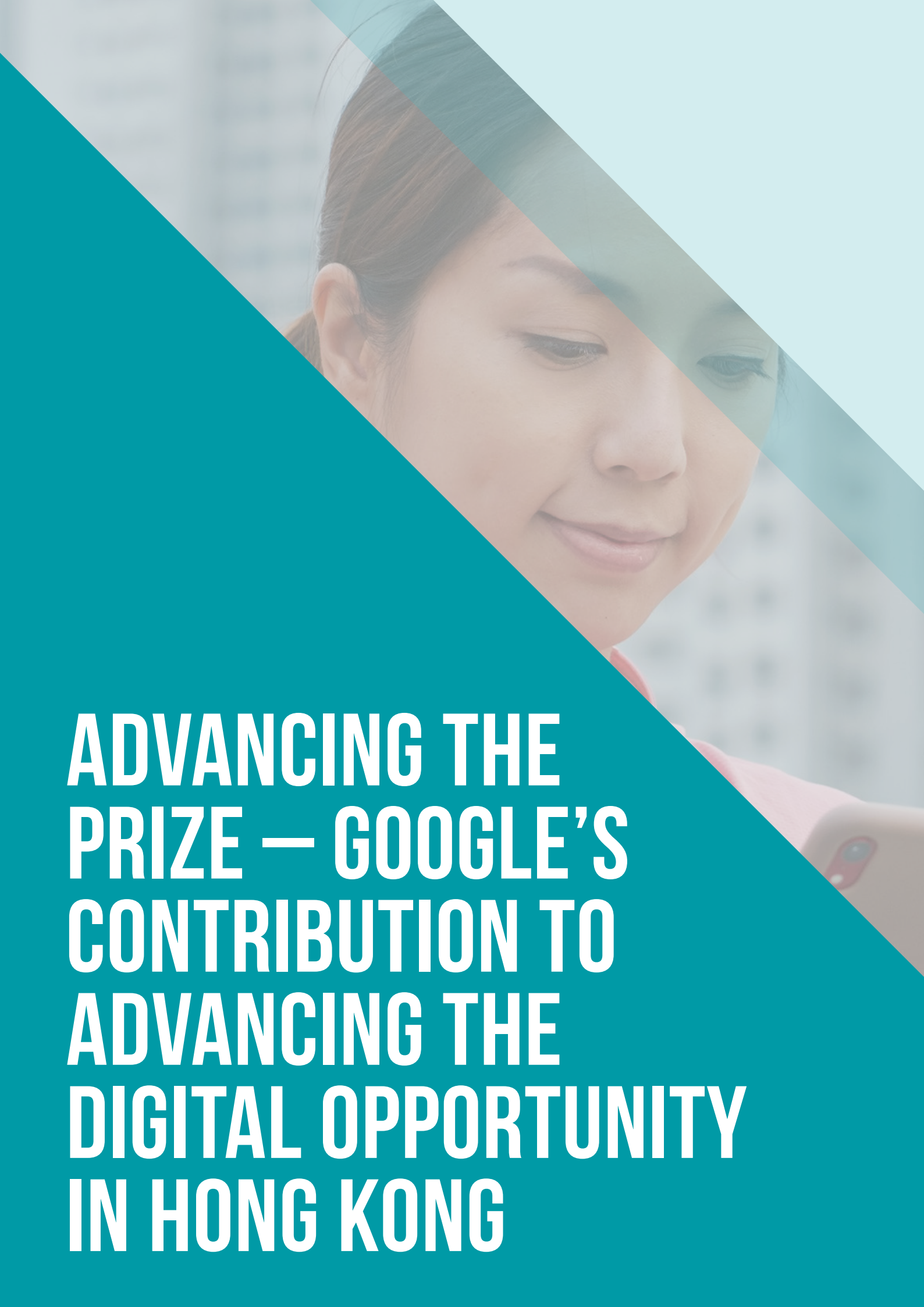
96. Association of Bay Area Governments (2018), Comprehensive Economic Development Strategy for the San Francisco Bay Area. Available at: https://abag.ca.gov/sites/default/files/complete_ceds_with_all_appendices.pdf
97. CGTN (2018), "China reveals blueprint for Guangdong-Hong Kong-Macao Greater Bay Area." Available at: https://news.cgtn.com/news/3d3d414e32637a4e32457a6333566d54/index.html

Joint Funding Scheme (MHKJFS) aims to encourage scientific research cooperation by supporting platform-based and collaboration-focused R&D projects that focus on promoting cooperation between Mainland China and Hong Kong institutions. The scheme aims to provide at least 10 percent of project costs for platform projects and at least 50 percent for collaborative projects.[98]

- **Supporting the establishment of regional platforms and talent development.** The **Hong Kong-Shenzhen Innovation and Technology Park**, which is still being developed, is planned to allow Hong Kong-based businesses and institutions to get access to R&D funding and supply chain and manufacturing capabilities from a broader region.[99] Companies will also have access to talent from both regions in Hong Kong and those across the border to Shenzhen, encouraging growth and businesses to set-up within the area.

Research has estimated that the GBA would support significant economic impacts. A study projected that GBA's GDP per capita will expand by over five percent annually from 2017 to 2030, increasing to RMB265,000 (USD40,900) in 2030, similar to the current level in the Greater Tokyo Area. The same study also estimated that the population in the entire GBA region will expand at an annual growth rate of 2.2 percent from 2017 to 2030 with strong talent inflow, increasing to a population size of over 100 million by 2030.[100] Consumers in the less economically developed cities in the province of Guangdong that are part of the GBA, such as Foshan and Dongguan, have also benefited from being part of the bay area, with consumer expenditures rising by 64 percent between 2012 and 2017, as compared to the 36 percent rise experienced by other city counterparts across China.[101]

98. Innovation and Technology Fund (2019), "Mainland-Hong Kong Joint Funding Scheme (MHKJFS)."
Available at: https://www.itf.gov.hk/en/funding-programmes/supporting-research/mhkjfs/index.html
99. Hong Kong Shenzhen Innovation and Technology Park (2021), Available at: https://www.hkstp.org/about-us/our-footprint/hsitp/
100. DBS Asian Insights (2019), Greater Bay Area: In-depth Study.
Available at: https://www.dbs.com.sg/vickers/en/research/featured/190515_insights_greater_bay_area.page
101. CEIC (2018), "Economic Breakdown: Guangdong-Hong Kong-Macau Greater Bay Area."
Available at: https://info.ceicdata.com/economic-breakdown-guangdong-hong-kong-macau-greater-bay-area



ADVANCING THE PRIZE — GOOGLE'S CONTRIBUTION TO ADVANCING THE DIGITAL OPPORTUNITY IN HONG KONG

Google makes significant contributions to the three pillars of digital transformation in Hong Kong, as outlined in Chapter 2. Google has trained students, job seekers and business owners in digital skills through various digital skilling programmes under the Grow with Google initiative such as Digital Garage and YouTube Creator Academy. Google is also digitally upskilling the population by launching the CS (Computer Science) First Curriculum initiative – a free computer science curriculum to promote coding education and computer sciences. Also, Google has been promoting the adoption of technologies in Hong Kong. Google launched the ShareJoy campaign and created HO JENG AR (which means "awesome") – a mobile application featuring an immersive experience with six augmented reality characters to showcase how creative technologies can do good for individuals, businesses, and for the community. Google has been nurturing the local technology and innovation ecosystem by embarking on the Smarter Digital City research project annually since 2017 to provide guidance for policymakers, businesses and other stakeholders in seizing the opportunities in the growing digital economy. Google's tools such as YouTube and Google Play also support content creators and developers by providing them an international platform to showcase their innovation.

In addition, Google's products support broader economic impact for businesses, consumers and the wider society. Businesses and consumers in the city were estimated to have derived total annual economic benefits from Google's products worth HKD28.4 billion (USD3.7 billion) and HKD16.6 billion (USD2.1 billion), respectively. These products include Google Search, Google Ads, AdSense,

"ADVANCING THE PRIZE"

GOOGLE'S CONTRIBUTION TO HONG KONG'S DIGITAL TRANSFORMATION JOURNEY

1. **Digitally upskill the population**
2. **Facilitate the adoption of emerging tech**
3. **Nurture the local technology and innovation ecosystem**

EXAMPLES OF INITIATIVES BY GOOGLE

- Google's **GROW WITH GOOGLE** initiative provides digital skills training for students, job seekers and business owners in Hong Kong
- Google introduces emerging technologies like AR through the **HO JENG AR** mobile application which showcases technologies through interactive activities
- Since 2017, Google published a series of research reports annually, **SMARTER DIGITAL CITY (SDC)**, to explore themes, provide recommendations, and track progress related to Hong Kong's digitisation

GOOGLE ALSO DELIVERS WIDER BENEFITS TO BUSINESSES, CONSUMERS AND SOCIETY IN HONG KONG

BUSINESSES

Through significant boosts to productivity and customer outreach, Google is estimated to support **HKD28.4 billion (USD3.7 billion)** worth of annual business benefits[1]

CONSUMERS

By helping consumers save time and generating value through their free products, Google is estimated to support **HKD16.6 billion (USD2.1 billion)** worth of annual benefits for consumers in Hong Kong[2]

SOCIETY

By enabling businesses to unlock new revenue streams and expand their businesses, Google indirectly supports **over 14,000 jobs** in Hong Kong. It also delivers a set of programmes to support underserved communities

1. Business benefits refer to the estimated economic impact from the following products: Google Search; Google Ads; AdSense; YouTube; and Google Play.
2. Consumer benefits refer to the estimated economic impact from the following products: Google Search; Google Maps; Google Drive; Docs, Sheets and Photos; YouTube; and Google Play.

Note: All data is based on AlphaBeta analysis using a range of original and third party sources. See Appendix in report for detailed methodology. Figures are estimated based on the latest available annual data as at time of research in 2020.

Google Play, YouTube, Google Maps, Google Drive, and Google Docs, Sheets and Photos. For businesses, economic benefits come in the form of increased revenue through increased customer outreach and access to new markets, as well as improved productivity through time savings. Consumers experience greater convenience, access to information, and more avenues for learning and skills development opportunities. Beyond its economic contributions to businesses and individuals, Google also indirectly supports benefits to the wider society in Hong Kong. By enabling businesses to unlock new revenue streams and expand their businesses through the use of Google Ads, AdSense, and YouTube, Google indirectly supports over 14,000 jobs in Hong Kong. Furthermore, Google also delivers intangible benefits through its programmes, such as extending digital skilling opportunities to underserved communities and promoting safe Internet use in Hong Kong.

3.1 GOOGLE CONTRIBUTES TO EACH OF THE THREE PILLARS OF DIGITAL TRANSFORMATION IN HONG KONG

Across the three pillars of action, Google has made significant contributions in Hong Kong through its programmes, products and services. To **digitally upskill the population (Pillar 1)**, Google has done the following:

- **Curate free educational resources to support digital skilling.** To address the digital talent shortage in Hong Kong, Google's cornerstone initiative, **Grow with Google** was launched to help equip the city's current and future workforce with digital skills through various programmes. Besides cultivating future digital talent, Google has been upskilling the current workforce with digital skills. In 2018, Google introduced the **Digital Garage** programme in Hong Kong which offers online and offline workshops in both Cantonese and English to train aspiring marketers in digital marketing skills. This initiative aims to help the workforce keep up with emerging industry demands for digital talent, while ensuring businesses are equipped with the digital know-how to connect with online customers. Individuals are also able to access other free initiatives to learn digital skills, including learning how to conduct digital marketing using **Google Ads**, attaining a certification on **Google Marketing Platform** proficiency, how to use **Google Analytics**, and how to create a free Business Profile on **Google My Business**.[102] Furthemore, marketers are able to tap on programmes such as **YouTube Creator Academy** to understand more about digital video platforms and learn how to engage content creators for different partnership models.[103]

- **Promote coding and computer sciences in educational curriculums.** To prepare the future workforce in coping with the evolving demands of the digital economy, Google launched the CS First Curriculum initiative – a free computer science curriculum to promote coding education and computer sciences. Together with schools and non-governmental organisations (NGOs), over 2,000 students in Hong Kong have

102. Google (2020), "Digital Marketing Gurus". Available at: https://storage.googleapis.com/gweb-for-hongkong.appspot.com/web/Digital%20Marketing%20Gurus%20%E6%95%B8%E7%A2%BC%E7%87%9F%E9%8A%B7%E4%BA%BA%E5%93%A1.pdf
103. Google (2021), "YouTube Creator Academy for Agencies". Available at: https://events.withgoogle.com/growwithgooglehk/youtube-creator-academy/

participated in CS First classes.[104] Under the CS First initiative, local teachers and volunteers running youth-focused training programmes are also offered training and resources, such as instructional videos, activities and coding projects, at **Train-the-Trainer** sessions to host their own classes and clubs. Google also introduced a free coding app, called **grasshopper**, that teaches beginners how to write JavaScript, a popular programming language, through fun and quick games on their smartphones.[105]

- **Provide resources and community support for women working in the technology field.** Google has been actively supporting community developer groups in Hong Kong, especially underrepresented communities in the technology field. **Google Developer Groups**, for example, have been established across Hong Kong for developers to learn, connect and innovate using Google's technologies. In particular, the **Women Techmakers** community group, which is part of the larger Google Developer Groups initiative, provides access to resources and helps build a supportive community for women within the technology sector.[106] The community group also offers a **Women Techmakers Scholars Programme** catered for female students from various cities, including Hong Kong.[107] This programme provides scholarships to female students enrolling in computer science, computer engineering and other relevant technical programmes in accredited universities. It also provides them with opportunities to connect with fellow scholars, network with Googlers and participate in workshops that develop their professional and personal skills.

To **facilitate the adoption of emerging technologies like AI and cloud (Pillar 2)**, Google has launched the following efforts in Hong Kong:

- **Introducing emerging technologies such as augmented reality (AR) through interactive activities.** As part of Google's commitment to help Hong Kong become a smarter digital city, Google launched the ShareJoy campaign and created HO JENG AR (which means "awesome") to showcase how creative technologies can do good for individuals, businesses, and the community.[108] HO JENG AR is a mobile application featuring an immersive experience with six iconic AR characters designed for Hong Kong. Users are guided by a virtual host named Lenni who provides step-by-step instructions on bringing AR characters to life by scanning real-life objects. As part of the initiative, Google also invited local developers to a **What's HO JENG AR** webinar to walk through the technical aspects of the app, promoting the use of digital technologies within Hong Kong.

- **Reducing barriers for businesses in adopting digital tools that improve productivity and efficiency.** Google's suite of products and services has played a vital role in improving the productivity and efficiency of businesses of all sizes, including the Hongkong and Shanghai Banking Corporation (HSBC). Box 4 illustrates an example of how Google Cloud helped HSBC in digitalising its business operations and improving its customer service at call centres.

To **nurture the local technology and innovation ecosystem (Pillar 3)**, Google is involved in the following areas:

- **Develop knowledge products on transforming Hong Kong to a Smarter Digital City.** Since 2017, Google Hong Kong published a series of annual research reports, **Smarter Digital City** (SDC), to explore and provide recommendations on topics of digitisation.[109] In 2015, Google and the Centre

104. Google for Hong Kong (2020), "Never stop learning, thrive with positive mindset and creativity". Available at: https://forhongkong.withgoogle.com/intl/en/cultivating-next-generation/
105. Google (2020), "Future Digital Talents / Students". Available at: https://storage.googleapis.com/gweb-for-hongkong.appspot.com/web/Future%20Digital%20Talents_Students%20%E6%96%B0%E6%99%89%E6%95%B8%E7%A2%BC%E4%BA%BA%E6%89%8D_%E5%AD%B8%E7%94%9F.pdf
106. Women Techmakers, "About us." Available at: https://www.womentechmakers.com/
107. Shiksha Study Abroad (2020), "Women Techmakers Scholars Program." Available at: https://studyabroad.shiksha.com/scholarships/women-techmakers-scholars-program
108. Google for Hong Kong (2020), "What is HO JENG AR?". Available at: https://forhongkong.withgoogle.com/intl/en/sharejoyhk/
109. Google for Hong Kong (2020), "How can Hong Kong become a Smarter Digital City?". Available at: https://forhongkong.withgoogle.com/intl/en/acceleration-digital-transformation/

BOX 4.
GOOGLE CLOUD HELPED AN INTERNATIONAL BANK DIGITALISE ITS BUSINESS OPERATIONS AND IMPROVE ITS CUSTOMER EXPERIENCE

HSBC is the largest bank in Hong Kong with over 90 percent of its global and local retail transactions conducted through digital platforms.[110] While digital banking is rising in popularity, customers continue to appreciate the "human touch" of call centre services, especially when they seek assistance. In 2020, the bank served over 1.5 million customers and its contact centre business had to handle over 14 million calls. Handling high call volumes efficiently and effectively was challenging, particularly in Hong Kong where most customers speak a mix of Cantonese and English that requires a high degree of experience to handle. As a result, quality assurance for this style of speech tends to be a particularly cumbersome and manual process.

To continue building a customer-centric culture, the bank saw AI as an opportunity to better understand customers' needs and worked with Google as one of its strategic partners. Using Google Cloud computing resources, the bank turned to AutoML Natural Language and Speech-to-Text to train machine learning models to classify, extract, and detect customer sentiment. Google's AI technologies managed to accurately convert spoken combinations of Cantonese and English and this created the institution's first in-house voice-processing solution that helps to identify areas of improvement in customer conversations. Moreover, Google Cloud significantly speeds up the time to review the quality of sales calls. A machine learning model could run in an hour, rather than a full week as would have been the case in a physical hardware environment. The solution also helps the bank quickly identify sales agents with room for improvement, cutting down 1,200 man-hours previously required to monitor all of its sales calls.

110. Google Cloud (2020), "HSBC: Using Google Cloud to improve customer service at call centers". Available at: https://cloud.google.com/customers/hsbc

for Entrepreneurship of The Chinese University of Hong Kong (CUHK) also released the first comprehensive research - the Crouching Tigers, Hidden Dragons report - assessing the viability of the local entrepreneurship ecosystem.[111] The report detailed action points for five key stakeholder groups such as investors and local businesses.

- **Build an entrepreneurial ecosystem by supporting promising start-ups.** Google has introduced several initiatives to support entrepreneurs in Hong Kong. For instance, in 2014, the company partnered with CUHK to launch the **Empowering Young Entrepreneurs Programme (EYE Programme)**.[112] EYE Programme was the first-of-its-kind initiative promoting entrepreneurship in the city and involved close industry-academic collaboration. The programme ran for three years and provided young entrepreneurs in Hong Kong a platform to innovate as well as to obtain mentorship and funding. In addition, Google's suite of products and services such as **Google Cloud** has not only supported the digital offerings of established industries, but also enabled the innovation of new products and services that contribute to the growth of Hong Kong's digital economy. Without having to devote additional resources to building the technical infrastructure and expertise, start-ups can leverage sophisticated software for image and language recognition, translation and other analytical tools on Google Cloud. To fuel Hong Kong's entrepreneurial ecosystem, Google has also been providing promising start-ups, such as Klook, with strategic support across consumer insights, marketing opportunities, and data analytics (see Box 5).

- **Provide training and tools for game developers to grow globally.** Google Play store provides a platform for local developers in Hong Kong to showcase their apps. For example, local developers

Kevin Wong and JoJo Chan won the Google Play Award in 2019 for the **Best Breakthrough App** during Google I/O 2019 – an annual developer conference held by Google in Mountain View, California.[113] The duo has developed an instant messaging app that promotes mindful and meaningful communication. The app offers specially designed stamps and is available in 21 languages. Within a year of going live on Google Play, the app attracted over one million downloads globally. Another prominent app developed by a local developer, Skytree Digital Limited, also went global after publishing its musical game Hachi Hachi on Google Play. After publishing on Google Play, the number of downloads for the game title was 20 times higher than its previous launches. The CEO of Skytree Digital Limited attributed the game's success to the support developers received from the Google Play team, including tools that tested user response when gaming images are changing, which helped the developer fine-tune the gameplay.

111. CUHK (2015), "Google and CUHK Center for Entrepreneurship challenge Hong Kong to "The 2% Mission" and call for synergy among five key groups to boost startup ecosystem". Available at: https://entrepreneurship.bschool.cuhk.edu.hk/eyeprogram2014/fullreport
112. CUHK (2014), "Empowering Young Entrepreneurs Program (EYE Program) 2014". Available at: https://entrepreneurship.bschool.cuhk.edu.hk/eyeprogram2014 and The Hang Sheng University of Hong Kong (2016), "Empowering Young Entrepreneurs Program (EYE Program) 2016". Available at: https://edc.hsu.edu.hk/empowering-young-entrepreneurs-program-eye-program-2016/
113. Google for Hong Kong (2020), "Empowering digital entrepreneurship". Available at: https://forhongkong.withgoogle.com/intl/en/fostering-digital-entrepreneurship/

BOX 5.
GOOGLE HELPS A LOCAL TRAVEL AGENCY TO REALISE ITS GLOBAL AMBITIONS

Klook is a global travel activities and services booking platform that originated in Hong Kong and provides over 100,000 offerings in more than 350 destinations around the world.[114] When the company was looking to expand beyond Hong Kong and Asia, Klook's co-founder, Eric Gnock Fah, decided to work with Google as a strategic partner. Google played an instrumental role in the company's global expansion by supporting critical aspects such as localising the company's advertisements and website for customers from different countries and gathering the consumer insights required for the business to grow its customer base rapidly. This includes understanding how prospective customers in different countries research, plan a trip and make bookings. Google has also been working closely with the company in improving its text-based search and expanding its features to include voice-search functions.

By providing a seamless way for travellers around the world to explore popular attractions and tours on its mobile app, the app attracts over 30 million visits monthly and is consistently ranked as one of the most popular Google Play store apps in Hong Kong, Taiwan, Malaysia, and Singapore. While maintaining its strong growth momentum in Asia, Klook is expanding its geographical footprint and over 20 percent of sales now come from the United States, Europe and Australia.

Photo Source: https://www.marketing-interactive.com/klook-kicks-off-aggressive-marketing-efforts-with-new-fundings

114. Google for Hong Kong (2020), "Empowering digital entrepreneurship".
Available at: https://forhongkong.withgoogle.com/intl/en/fostering-digital-entrepreneurship/

GOOGLE'S ECONOMIC IMPACT IN HONG KONG

BUSINESS BENEFITS

Google supports
HKD28.4 BILLION (USD3.7 BILLION)
in annual benefits to businesses in Hong Kong[1]

Google Search saves the average employee in Hong Kong about
3.8 DAYS PER YEAR
through almost instantaneous access to information online

CONSUMER BENEFITS

Google supports
HKD16.6 BILLION (USD2.1 BILLION)
in annual benefits to consumers in Hong Kong[2]

The average **Google Search** in Hong Kong user saves
4.3 DAYS A YEAR
looking for answers, as compared to traditional offline methods

According to AlphaBeta research,
OVER 40%
of **YouTube** users in Hong Kong say they use online video services to learn advanced digital skills

SOCIETAL BENEFITS

By enabling businesses to unlock new revenue streams and expand their businesses, Google indirectly supports **over 14,000 jobs** in Hong Kong

Google.org supported INCO with a grant toward their initiative to support local education organisations that are helping educators and students access resources for remote learning

1. Business benefits refer to the estimated economic impact from the following products: Google Search; Google Ads; AdSense; YouTube; and Google Play.
2. Consumer benefits refer to the estimated economic impact from the following products: Google Search; Google Maps; Google Drive; Docs, Sheets and Photos; YouTube; and Google Play.
Note: All data is based on AlphaBeta analysis using a range of original and third party sources. See Appendix in report for detailed methodology. Figures are estimated based on the latest available annual data as at time of research in 2020.

3.2 BENEFITS OF GOOGLE SEARCH AND OTHER TECHNOLOGIES TO BUSINESSES, CONSUMERS AND SOCIETY

Google's services, such as Google Search, Google Ads, and Google Maps, bring about substantial economic benefits in Hong Kong. This study finds that the annual economic value presented by Google's applications and platforms are worth HKD28.4 billion (USD3.7 billion) for businesses and HKD16.6 billion (USD2.1 billion) for consumers.[115] An overview of the assessed economic benefits of Google services to businesses and consumers in Hong Kong is provided in Exhibit 5. It is important to note that these benefits relate to direct economic benefits received, and do not include the flow-on economic effects generated (see Box 6 for further details). In addition, Google also supports benefits to the wider society in Hong Kong. These include indirectly supporting over 14,000 jobs in its economy,[116] as well as other intangible benefits through its programmes, such as extending digital skilling opportunities to underserved communities and promoting safe Internet use in Hong Kong.

BENEFITS TO BUSINESSES

GOOGLE HELPS BUSINESSES BOOST THEIR REVENUES

Google applications broaden the reach of businesses in Hong Kong to new customers and markets. Digital marketing and commerce solutions across Google and YouTube platforms help businesses reach their customers and make the business stand out to online shoppers. **Google Ads** is estimated to generate HKD18.1 billion (USD2.3 billion) annually in the form of net returns to businesses in Hong Kong from advertising on Google Search results of relevant keywords. Beyond search advertising, businesses in Hong Kong also benefit from displaying advertisements on Google's network of publisher sites such as websites, blogs, and forums through **AdSense**. These net returns are estimated at HKD481 million (USD62.1 million) annually. Meanwhile, by leveraging the various formats of advertisements enabled by **YouTube**, businesses are estimated to achieve HKD869 million (USD112 million) in net advertising returns annually.

In addition, Google provides new sources of income for content creators in Hong Kong. By allowing content creators such as online journalists, media sites, bloggers, and writers to earn income by hosting advertisements on their sites, **AdSense** is estimated to have helped content creators in Hong Kong monetise space on their websites and generate a total annual income of HKD6 billion (USD771 million). **YouTube** also benefits video content creators in Hong Kong to turn their passions into professional storytelling with quality content and earn revenue through placing advertisements on their videos. This is estimated to bring content creators in Hong Kong a total of HKD354 million (USD45.6 million) in annual advertising revenue. Through Google's ecosystem, creators are connected to an international fanbase and are able to build meaningful relationships with the online community. In Hong Kong, Google launched the **Creator Spotlight Programme** which features up-and-rising YouTube creators to help them reach a more diverse audience and accelerate their growth while encouraging quality content.[117]

115. The products included in these estimations include Google Search, Google Ads, AdSense, Google Play, Google Maps, YouTube, Google Drive, and Google Docs, Sheets and Photos.
116. Jobs supported refer to new jobs that may have been created through a business' use of Google's platforms, as well as ongoing employment of jobs that previously existed.
117. Google for Hong Kong (2020), "Empowering digital entrepreneurship". Available at: https://forhongkong.withgoogle.com/intl/en/fostering-digital-entrepreneurship/

EXHIBIT 5:

OVERVIEW OF ANNUAL BENEFITS SUPPORTED BY GOOGLE IN HONG KONG

TYPE OF BENEFIT	EASE OF ACCESS TO INFORMATION	ENTERTAINMENT AND ENRICHMENT
RELEVANT PRODUCT/S	**Google Search**	**YouTube, Google Play & Android**
BUSINESS BENEFITS	• By allowing for almost instantaneous access to information online, Google Search helps businesses save **3.8 days** a year per worker in Hong Kong	• App developers in Hong Kong earn about **HKD2.6 billion (USD341 million)** in revenue from both domestic and international markets through the Google Play platform per year • Android enables app developers to save up to **25%** of development time and target more than **1 billion** users worldwide[1]
CONSUMER BENEFITS	• By providing almost instantaneous access to information, the average Google Search user in Hong Kong saves about **4.3 days** seeking information online per year • The total annual consumer benefits derived from Google Search are estimated at **HKD3.7 billion (USD477 million)**	• Consumers can choose from over **3.5 million** apps available on the Android ecosystem[2] • The total annual consumer benefits derived from entertainment and enrichment tools of Google Play and YouTube are estimated at **HKD6.3 billion (USD813 million)** annually

1. App Annie (2017), "Top Predictions for the App Economy in 2018". Available at: https://www.appannie.com/en/insights/market-data/predictions-app-economy-2018/

2. AlphaBeta and Google (2017), The Economic Impact of Geospatial Services: How Consumers, Businesses and Society Benefit from Location-based Information. Available at: https://alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report_Sept-2017.pdf

3. Net advertising benefits refer to additional revenue earned from advertising less the advertising cost.

Note: Figures are estimated based on the latest available annual data as at time of research in 2020.

SOURCE: AlphaBeta analysis

	INCREASED PRODUCTIVITY AND CONVENIENCE	ADVERTISING BENEFITS	TOTAL BENEFITS:
	Google Maps, Drive, Photos, Docs & Sheets	**YouTube, Google Ads & AdSense**	
	• The Google My Business (GMB) function in Google Maps allows customers to discover local businesses. Globally, the additional revenue earned by an average small and medium-sized business as a result of GMB has been estimated to be between **USD212-250** per year[2]	• Google Search and Ads bring about **HKD18.1 billion (USD2.3 billion)** in net advertising benefits to businesses in Hong Kong annually[3] • Web publishers and content creators in Hong Kong earn about **HKD6.3 billion (USD817 million)** in revenue from AdSense and YouTube annually • Advertises in Hong Kong gain **HKD1.4 billion (USD174 million)** in net advertising benefits annually from displaying advertisements on websites and videos using AdSense and YouTube[3]	**HKD28.4 BILLION (USD3.7 BILLION)**
	• The total annual consumer benefits derived from Google Maps, Drive, Photos, Docs, and Sheets that increase productivity and convenience are estimated at **HKD6.6 billion (USD848 million)** annually	Nil	**HKD16.6 BILLION (USD2.1 BILLION)**

BOX 6.
MEASURING THE BENEFITS OF GOOGLE'S PRODUCTS TO BUSINESSES AND CONSUMERS

The benefits of Google's products to businesses and consumers estimated in this research focus on the direct economic impact received by them. Because of the different nature of the benefits experienced from the products, different approaches were utilised for businesses and consumers. The business benefits supported by Google include the gross revenue, income or savings generated by businesses using Google products. It is important to note that these benefits do not include the flow-on economic effects generated, such as further purchases from their suppliers, or the economic activity generated by the employees of these businesses who spend their wages in the broader economy (indirect or induced spend). This is because of the intention to gauge the direct impacts that business users of Google's products receive. On the other hand, for benefits to consumers, it is important to note that these are challenging to measure and calculate because individuals typically do not pay for the services. In the absence of price indicators, the economic "willingness to pay" principle was used to estimate the value of consumer benefits by asking individuals how much they value specific products. Time savings accrued to consumers from their use of Google Search (which increases the efficiency of information gathering) were also measured to derive a measure of the convenience these products bring to them. Appendix C shows a detailed methodological explanation of how the benefit of each product was sized.

For example, local YouTube creator Sunny, from arhoTV, quit his previous job and started his YouTube channel. By producing content ranging from music production to everyday life, YouTube has enabled Sunny to share his imagination and creativity with people from different walks of life while creating an enriching life experience for himself.

Google's digital product distribution platform, **Google Play**, as well as the operating system, **Android**, have resulted in a variety of benefits to app developers in Hong Kong. App developers are estimated to earn an annual income of about HKD2.6 billion (USD341 million) from Google Play in both the domestic and global markets.[118] Further, through the Android operating system, app developers in Hong Kong can readily reach more than one billion users globally.[119] It was additionally found that Android app developers can save up to 25 percent in development time from not having to port their apps across different operating systems.

Exhibit 6 summarises the estimated annual business benefits in the form of revenue gains experienced by businesses in Hong Kong from Google Search and Ads, AdSense, YouTube, and Google Play.[120]

GOOGLE HELPS BUSINESSES INCREASE PRODUCTIVITY AND SAVE TIME

Google helps businesses save time by enhancing employees' productivity by improving the speed and ease of access to information and research. In particular,

EXHIBIT 6:
GOOGLE IS ESTIMATED TO BRING ABOUT HKD28.4 BILLION (USD3.7 BILLION) WORTH OF ANNUAL BENEFITS TO BUSINESSES IN HONG KONG

PRODUCT	DESCRIPTION OF BENEFITS	ESTIMATED ANNUAL BENEFITS
Google Search & Ads	Net advertising benefits for businesses[1]	HKD18.1 billion (USD2.3 billion)
AdSense	Net advertising benefits for businesses[1]	HKD481 million (USD62.1 million)
	Income generated by website publishers through AdSense	HKD6 billion (USD771 million)
YouTube	Net advertising benefits for businesses[1]	HKD869 million (USD112 million)
	Advertising revenue earned by YouTube video creators	HKD354 million (USD45.6 million)
Google Play	Income generated by app developers in Hong Kong from both the domestic and international markets through Google Play	HKD2.6 billion (USD341 million)
TOTAL ANNUAL BUSINESS BENEFITS IN HONG KONG:		**HKD28.4 BILLION (USD3.7 BILLION)**

1. Net advertising benefits refer to additional revenue earned from advertising less the advertising cost.
Note: Figures are estimated based on the latest available annual data as at time of research in 2020. Numbers may not sum due to rounding.
SOURCE: AlphaBeta analysis

118. Google Play is a digital distribution service operated and developed by Google. It serves as the official app store for the Android operating system, which refers to the mobile operating system developed by Google for touchscreen mobile devices such as smartphones and tablets. Google Play users are able to browse and download applications developed with the Android software development kit.
119. AlphaBeta (2018), "AlphaBeta research brief: The estimated economic impact from Android across five Asian markets".
Available at: https://www.alphabeta.com/wp-content/uploads/2017/08/180820-Android-Economic-Impact.pdf
120. While the benefits to Ad Grants are in the form of free advertising provided to non-profits (not returns on advertising), they are also included in this section as this amount of free advertising will also lead to increased donor interest and funding for non-profits.

Google Search minimises the time for businesses to acquire information by arranging and simplifying the vast array of content on the Internet. The ability to rapidly find relevant data and information provides tremendous productivity benefits for employees, with each employee saving on average about 3.8 days annually.

GOOGLE SUPPORTS BUSINESSES AND WORKERS DURING THE COVID-19 PANDEMIC

Box 7 shows examples of how Google's applications and initiatives have supported the government, businesses and students in weathering the effects of the COVID-19 pandemic.

BENEFITS TO CONSUMERS

CONSUMERS IN HONG KONG EXPERIENCE ANNUAL BENEFITS WORTH HKD16.6 BILLION (USD2.1 BILLION) FROM GOOGLE'S SERVICES

The consumer benefits supported by Google are challenging to measure and calculate because individuals typically do not pay for the services. In the absence of price indicators, the economic "willingness to pay" principle was adopted to estimate the value of consumer benefits by asking individuals how much they value specific products (see Box 6). Taken together, Google Search, Google Maps, YouTube, Google Play, Drive, Photos, Docs, and Sheets are estimated to bring about total annual consumer benefits worth HKD16.6 billion (USD2.1 billion). This value includes three main categories of benefits provided by Google applications: ease of access to information (Google Search), entertainment and enrichment (Google Play and YouTube), and enhanced productivity and convenience (Google Maps, Drive, Photos, Docs, and Sheets). Exhibit 7 shows the breakdown of consumer surplus by category.

GOOGLE PROVIDES CONSUMERS IN HONG KONG BETTER ACCESS TO INFORMATION

Google provides benefits to consumers in Hong Kong by allowing them to instantly access a vast array of information online. The total annual consumer surplus brought about by **Google Search** is estimated at HKD3.7 billion (USD477 million) (Exhibit 7). Based on an international study showing that a search for a piece of information that takes 21 minutes in the library takes only seven minutes online, it is estimated that Google Search saves consumers in Hong Kong an average of 4.3 days per year.[121]

In addition, Google Ads help improve the Internet browsing experience for consumers in Hong Kong. For example, based on the consumers' specific interests and demographic information, Google's machine learning algorithm will predict and match prospective buyers with ads for items or services that they are looking for.[122] This enables buyers to receive more relevant advertisement that they are more likely to click on to find out more or make a purchase.

GOOGLE'S SERVICES ENTERTAIN AND ENRICH CONSUMERS IN HONG KONG

YouTube has presented substantial benefits to consumers as a source of free entertainment as well as a channel for consumers to learn new skills (e.g., online "how-to" videos) or gain new knowledge (e.g., online documentaries). According to AlphaBeta research, over 40 percent of YouTube users in Hong Kong say they used online video services to learn advanced digital skills such as coding, software programming, and mobile application and website development.[123]

Google Play and **Android** have also brought a variety of benefits to consumers in Hong Kong. For example, Android enables consumers to choose from over 3.5 million apps available on the Android ecosystem.[124]

121. Yan Chen, Grace Young Joo Jeon and Yong-Mi Kim (2014), A day without a search engine: an experimental study of online and offline search. Experimental Economics. Available at: https://link.springer.com/article/10.1007/s10683-013-9381-9
122. Google Ads Help (2021), "About audience targeting". Available at: https://support.google.com/google-ads/answer/2497941?hl=en
123. Google/AlphaBeta Economic Impact Report survey, n = 531. Percent represents use of online video services to learn advanced digital skills amongst consumers in Hong Kong for whom YouTube is their most frequently used online video service.
124. App Annie (2017), "Top Predictions for the App Economy in 2018". Available at: https://www.appannie.com/en/insights/market-data/predictions-app-economy-2018/

BOX 7.
GOOGLE'S CONTRIBUTIONS TO THE GOVERNMENT, BUSINESSES, AND STUDENTS DURING THE COVID-19 PANDEMIC

GOVERNMENT: SAFEGUARDING PUBLIC HEALTH AND ENABLING EFFICIENT INFORMATION DELIVERY

Google supported the government's COVID-19 response efforts by providing authoritative information across its products, introducing helpful solutions like **Exposure Notifications technology**, and doubling down on efforts to help fight misinformation (e.g., vaccine misinformation).[125]
The Exposure Notifications technology supports public health authorities in their contact tracing efforts by exchanging privacy-preserving random identifiers (IDs) via Bluetooth between users and periodically checking the user's identity against a list of positive COVID-19 cases.

BUSINESSES: ENABLING REMOTE WORKING ARRANGEMENTS DURING THE PANDEMIC

As more businesses adjust to work-from-home arrangements during the pandemic, the Google Meet video-conferencing software's advanced capabilities (e.g., allowing larger meetings of up to 250 participants per call) were made available free of charge to all businesses in Hong Kong that use Google Workspace (formerly known as G Suite). This has allowed companies to stay connected and work remotely from anywhere on the globe.[126]

When the COVID-19 outbreak occurred, many businesses saw a fall in in-store revenues as most people stayed at home and refrained from venturing outdoors for fear of contracting the virus. Google My Business was instrumental in creating a digital storefront for businesses to sell online and expand their outreach to gain new customers. By creating a business listing on Google My Business, potential customers were able to search for local businesses on Google Search and Google Maps, and find out more about the products and services offered. Besides its free Business Profile, Google also

125. Google (2020), "Exposure Notifications: end of year update."
Available at: https://blog.google/inside-google/covid-19/exposure-notifications-end-year-update/
126. Google Cloud (2020), "Helping businesses and schools stay connected in response to coronavirus."
Available at: https://cloud.google.com/blog/products/g-suite/helping-businesses-and-schools-stay-connected-in-response-to-coronavirus

BOX 7. (CONT'D) GOOGLE'S CONTRIBUTIONS TO THE GOVERNMENT, BUSINESSES, AND STUDENTS DURING THE COVID-19 PANDEMIC

added new features to facilitate businesses in capturing new sources of revenue that emerged during the COVID-19 pandemic. With increasing consumer demand for food delivery and takeout, businesses that created Business Profiles on Google My Business were given the option of adding dining attributes such as "takeout" and "no-contact delivery" on their profile.[127] This greatly enhanced the ease with which customers could order food while minimising physical contact. At the same time, businesses could continue operating while abiding by social distancing measures.

In addition, Google's philanthropic arm, Google.org, provided grant funding to support Youth Business International's COVID-19 Rapid Response and Recovery Programme initiative, to support underserved micro, small and medium-sized businesses in 32 countries across Europe, the Middle East, Africa, and Asia-Pacific during these challenging times.[128] Through its global network of enterprise service organisations, the Youth Business International designed localised response services, including crisis helplines, targeted advice and signposting, and online trainings through webinars and mentoring. At the regional level, active regional communities of enterprises were developed to share best practices on how to support MSMEs in tiding through the pandemic.

STUDENTS: ENABLING STUDENTS TO LEARN FROM HOME

Concerns over the transmission of COVID-19 led to school closures in Hong Kong. As part of Google's commitment to nurturing the future workforce, Google Workspace for Education supported distance learning by helping teachers and students stay connected remotely. One of the digital tools available on Google Workspace for Education is Google Classroom, which enables teachers to create virtual classrooms, organise assignments, boost collaboration, and foster better communication by providing students timely feedback on their work. Besides digital tools delivered through Google Workspace for Education, YouTube Learning Hub provides learning videos designed for families. In addition, Google launched Teach from Home – a central hub of information, tips, training and tools on the Google Workspace for Education site to help teachers conduct classes online.[129]

127. Google My Business Help (2020), "Food businesses affected by COVID-19". Available at: https://support.google.com/business/answer/9805441?hl=en
128. Youth Business International (2020), "COVID-19 Rapid Response and Recovery Programme supported by Google.org". Available at: https://www.youthbusiness.org/initiative/covid-19-rapid-response-and-recovery-programme
129. Google The Keyword (2020), "Helping educators and students stay connected". Available at: https://www.blog.google/outreach-initiatives/education/helping-educators-and-students-stay-connected/

EXHIBIT 7:

GOOGLE IS ESTIMATED TO SUPPORT A TOTAL HKD16.6 BILLION (USD2.1 BILLION) WORTH OF ANNUAL CONSUMER SURPLUS IN HONG KONG

ESTIMATED ANNUAL CONSUMER SURPLUS OF GOOGLE PRODUCTS IN HONG KONG
CONSUMER SURPLUS (HKD)

TYPE OF BENEFIT	PRODUCT	ANNUAL CONSUMER SURPLUS
Ease of access to information	Google Search	HKD3.7 billion (USD477 million)
Entertainment and enrichment	Google Play	HKD6.3 billion (USD813 million)
	YouTube	
Enhanced productivity and convenience	Google Maps	HKD6.6 billion (USD848 million)
	Google Drive, Photos, Docs and Sheets	
	TOTAL ANNUAL CONSUMER SURPLUS:	**HKD16.6 BILLION (USD2.1 BILLION)**

Note: Figures are estimated based on the latest available annual data as at time of research in 2020.
SOURCE: AlphaBeta analysis

Meanwhile, **Google Play** is a convenient platform for consumers to access a range of smartphone applications, as well as digital books, music, and films. YouTube and Google Play are estimated to bring a total consumer surplus of HKD6.3 billion (USD813 million) to consumers in Hong Kong annually.[130]

GOOGLE'S SERVICES IMPROVE PRODUCTIVITY AND CONVENIENCE FOR CONSUMERS IN HONG KONG

By allowing digital data to be stored and accessed through multiple devices, including laptops, tablets, and smartphones, Google's cloud-based services such as Google Drive, Photos, Docs, and Sheets provide great convenience to consumers in Hong Kong. These services enable them to manage folders, share ideas, and get things done more effectively.

Google Maps brings about productivity in the public transport and driving journeys of consumers in Hong Kong through the service's wayfinding and navigation feature, which optimises these trips using real-time data such as public transport arrival times and road traffic conditions. The total annual consumer benefits derived from productivity-enhancing tools of Google Maps, Drive, Photos, Docs, and Sheets are estimated at HKD6.6 billion (USD848 million).

130. Google/AlphaBeta Economic Impact Report survey, n = 531. The total consumer surplus represents the economic benefits to consumers in Hong Kong from using Google Play. See more details in Appendix C for the methodology.

BENEFITS TO SOCIETY

Google's products also support benefits to the wider society in Hong Kong. These include the creation of new jobs in its economy (brought about by business expansions enabled by Google's products), as well as other intangible benefits through its programmes.

GOOGLE INDIRECTLY SUPPORTS OVER 14,000 JOBS IN HONG KONG

At a broader level, Google has facilitated job creation in the economy through its products. Through Google Ads, AdSense and YouTube, Google indirectly supports the creation of **over 14,000 jobs** in Hong Kong.[131] These jobs are created through the use of Google products that lead to businesses expanding their customer bases and increasing revenue. For instance, businesses that expand their reach to new markets through advertising via Google Ads, AdSense and YouTube would require increased labour to meet this additional demand.

GOOGLE BROADENS ACCESS TO DIGITAL OPPORTUNITIES FOR UNDERSERVED COMMUNITIES

During the pandemic, Google.org, Google's philanthropic arm, launched a USD10-million (HKD77.7-million) Distance Learning Fund to help educators and students get the resources they need to ensure learning continuity, especially in underserved communities. As part of the **Distance Learning Fund**, Google.org provided a grant to INCO, a global non-profit supporting local education organisations including those in Hong Kong and other locations helping educators and students to adapt to distance learning.[132]

131. Jobs supported refer to new jobs that may have been created through a business' use of Google's platforms, as well as ongoing employment of jobs that previously existed.
132. Google The Keyword (2020), "The shift to distance learning in Asia Pacific". Available at: https://blog.google/around-the-globe/google-asia/shift-distance-learning-asia-pacific/

GOOGLE ENSURES SAFE AND SECURE INTERNET USE

Google Hong Kong also worked with WebOrganic, the Information Technology Resource Centre of the Hong Kong Council of Social Service, in launching various campaigns to promote internet safety and digital literacy in the past few years. In 2019 and 2020, the programme titled PaMa Café: My Kids x Internet focused on raising parents' awareness of the positive use of the Internet and providing practical guidance to parents on communicating with their kids about internet safety.[133] The programme covered over 600 families in total in 2019 and 2020.

In 2020, with the support of Hong Kong's Office of the Privacy Commissioner for Personal Data (PCPD), along with community partner Caritas Youth and Community Service as well as WebOrganic, Google launched the safer internet campaign **Be Safe and Smart Online**.[134] As part of its outreach efforts, local illustrator, Dustykid, helped create a series of bilingual illustrations on easy-to-follow steps to safeguard online accounts, protect personal information, and be smart and kind to others online.

Another free resource available to Hong Kong parents and kids include **Be Internet Awesome**, which provides kids, parents and educators the knowledge they need to make smart and responsible choices online.[135] Through the multi-faceted Be Internet Awesome programme, Google created a fun and free web-based game called Interland which allows children to put the key lessons of digital safety into hands-on practice with four challenging games.[136] In addition, the Be Internet Awesome curriculum provides lesson plans for educators to teach online safety through a series of classroom activities so that students can explore the online world with confidence. Meanwhile, parents driving the online safety conversation at home can encourage the entire family to take the Be Internet Awesome pledge after learning how to navigate the Internet confidently and safely.

133. OGCIO (2021), "Keynote Speech by Mr. Tony Wong, JP, Deputy Government Chief Information Officer, at the "Safer Internet Day 2020 – Virtual Closing Ceremony of 2nd 'PaMa Café: My Kids x Internet'". Available at: https://www.ogcio.gov.hk/en/news/speeches/2021/01/sp_20210123.html
134. WebOrganic (2019), "為孩子打開互聯網世界的大門". Available at: http://www.weborganic.hk/others/sid/%E6%96%BO%E8%81%9E%E7%A8%BF_%E5%9C%8B%E9%9A%9B%E4%BA%92%E8%81%AF%E7%B6%B2%E5%AE%89%E5%85%A8%E6%97%A52019.pdf
135. Google (2020), "Educators". Available at: https://storage.googleapis.com/gweb-for-hongkong.appspot.com/web/Educators%20%E6%95%99%E5%B8%AB.pdf
136. Google (2021), "Be Internet Awesome". Available at: https://beinternetawesome.withgoogle.com/en_us/

APPENDIX: METHODOLOGY

A: SIZING THE ECONOMIC VALUE OF DIGITAL TECHNOLOGIES

This document provides the detailed methodology, assumptions and sources of information used to quantify the potential economic impact of digital technologies for Hong Kong in 2030.

APPENDIX A1: OVERALL APPROACH

A four-step methodology was used to understand the potential economic impact created by digital technologies in 2030 (Exhibit A1).

STEP 1: IDENTIFY DIGITAL TECHNOLOGIES

Several existing research reports on current and emerging digital technologies were reviewed to identify the most relevant technologies to focus on for this analysis in terms of their potential economic impact. There was a large body of research by academics, development practitioners, non-for-profits as well as the private and public sector on the interaction between technologies and economic development. In 2013, McKinsey Global Institute identified 12 disruptive trends that would transform life, business and the global economy.[137] Of these trends, seven were considered digital in nature: mobile internet; automation of knowledge; IoT which was often combined with geospatial and satellite technology (e.g., remote sensing); cloud technology; advanced robotics; autonomous and near autonomous vehicles; and additive manufacturing (more commonly known as 3D printing).

Since 2013, several technologies have been added to this list due to potentially transformational economic and social impact. For example, the UK-based international development network, Bond, noted rapid changes in the technologies shaping international development between 2016 and 2019. Emerging technologies included big data, financial technology (Fintech), machine learning and even blockchain. These technologies were in no way mutually exclusive and the line between what constituted a different technology versus an application of a technology could be blurred. For example, AI utilised big data which often relied on cloud computing technology to provide the storage and computational horsepower to run machine learning algorithms and other analytics. Similarly, autonomous vehicles contained a multitude of sensors, many of which were internet-enabled i.e., IoT. Exhibit 1 in Chapter 1 provides an overview of eight key digital technologies with significant implications for economic development.

STEP 2: ALIGN ON FOCUS SECTORS

To understand the current and potential economic output of these digital technologies, a set of focus sectors have been identified. These sectors were selected based on two steps:

- Clustering industries, at the ISIC 1 digit level, into broader sectors for convenient analysis.[138] This was guided by the individual industry's relevance for digital technologies (based on past research quantifying the potential industry benefits of these digital technologies).[139]

137. McKinsey Global Institute (2013), Disruptive technologies: Advances that will transform life, business, and the global economy. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

138. These sectors uniquely match to the relevant International Standard Industrial Classification of All Economic Activities (ISIC) with the exception of "Consumer, retail & hospitality", combining ISIC Sector G: Wholesale and retail trade; repair of motor vehicles and motorcycles and Sector I: Accommodation and food service activities; "Infrastructure", which combines ISIC Sectors F: Construction and L: Real estate activities; and "Resources", combining the ISIC Sector B: Mining and quarrying; Sector D: Electricity; gas, steam and air conditioning supply and Sector E: Water supply, sewerage, waste management and remediation activities.

139. This was based on a range of reports. See for example, McKinsey Global Institute (2014), Southeast Asia at the crossroads: Three paths to prosperity (Available at: https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Asia%20Pacific/Three%20paths%20to%20sustained%20economic%20growth%20in%20Southeast%20Asia/MGI%20SE%20Asia_Executive%20summary_November%202014.pdf); and McKinsey Global Institute (2014), India's tech opportunity: Transforming work, empowering people (Available at: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/indias-tech-opportunity-transforming-work-empowering-people).

- Prioritizing the sectors based on their importance for Gross Domestic Product (GDP), proxied by the sector's share of the market's GDP. Each selected sector must represent more than 1.5 percent of the market's GDP.

The Information and Communication Technology (ICT) industry classification was excluded due to its value-added to the economy being almost entirely driven by technology and most of the value from digital technologies in this sector would have been captured in other sectors as an input to production.
Based on these steps, ten sectors were selected.[140] These sectors consisted of Agriculture and food; Consumer, retail and hospitality services; Education and training; Financial services; Government; Health; Infrastructure (including utilities such as energy and water); Manufacturing; Professional services; and Transport services.

STEP 3: IDENTIFY RELEVANT TECHNOLOGY APPLICATIONS IN FOCUS SECTORS

Relevant technology applications in the focus sectors and their sources of value (e.g., reduced wastage in production, enhanced consumer offerings) were identified based on a detailed review of the academic literature for each of the eight focus technologies. These technology applications included tangible drivers of business value, such as the use of remote

EXHIBIT A1:

A FOUR-STEP METHODOLOGY WAS USED TO UNDERSTAND HOW DIGITAL TECHNOLOGIES COULD TRANSFORM ECONOMIC DEVELOPMENT

	STEP 1 Identify digital technologies	STEP 2 Align on focus sectors	STEP 3 Identify relevant technology applications in focus sectors	STEP 4 Size the value in 2030
Activities	Identify key digital technologies that academic literature has shown to be important for driving business and consumer value	Identify key sectors of the economy, based on relevance of those technologies and their importance for overall jobs and GDP	Understand relevant technology applications in focus sectors, including sources of value	Estimate the value (in local currency terms) of these technology applications in each sector in 2030 based on full adoption scenario
Methodology	Industry reports – e.g., McKinsey Global Institute, World Economic Forum	Technology reports to identify sector-impact of technologies; local market data for importance of sectors to GDP, jobs	Review of sector-level technology reports	Case studies, with top-down "sanity check" based on comparison to other research reports on overall value of technologies

140. In Hong Kong, all ten sectors have fulfilled the criterion in Step 2.

patient monitoring to enable hospital-level care in homes using advanced sensors, smart medical devices, and robotics. A list of these technology applications, categorised by sector and key digital technology, is shown in Exhibit 2 in Chapter 1. Several emerging digital technologies such as blockchain were considered but not analysed as they were still in the nascent stages and economic impact estimates were difficult to obtain.

STEP 4: SIZE THE VALUE IN 2030

The value (in local currency terms) of these technology applications in each sector was then quantified in 2030 (based on assessed potential linked to benchmarks).

The **"Full adoption"** scenario was analysed. In this scenario, the city was assumed to achieve full digital adoption (100 percent) in the 41 digital technology applications across ten sectors. This scenario was modelled to frame the maximum achievable opportunity.

A series of international and city-specific case studies were used for each technology application in the sizing. A "sanity check" of the results was then done by comparing the overall sector and economy-wide estimates with other research reports. **These estimates do not represent GDP or market size (revenue), but rather economic impact such as productivity gains, increased revenues and cost savings.**

APPENDIX A2: SPECIFIC APPROACHES, ASSUMPTIONS AND SOURCES

Table 1 summarises the key metrics and sources used commonly across the sizing of the economic opportunities of digital technology applications.

The specific assumptions and sources of information used to size each digital technology application in each sector are shown below. These assumptions were used to estimate the "Full adoption" scenario in 2030.

TABLE 1: KEY METRICS AND SOURCES FOR SIZING ECONOMIC OPPORTUNITIES

METRICS	SOURCE
GDP / GDP per capita	• World Bank GDP statistics • International Monetary Fund (IMF) Real GDP growth estimates • Census and Statistics Department (Hong Kong)
Population	• United Nations Department of Economic and Social Affairs Population datasets
Labour Force	• International Labour Organisation (ILO) • World Bank Labour Force statistics • Census and Statistics Department (Hong Kong)
Wage	• Census and Statistics Department (Hong Kong)
Exchange rates	• OFX

FINTECH

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. DIGITAL BANKING SERVICES (FINANCIAL SERVICES)		**INCREASED REVENUES**
Use of Internet and mobile technologies to reduce operational and risk costs, and improve service delivery	Sized based on the cost savings from digitisation such as the electronic onboarding of clients, leveraging machine learning and robotics to create operational improvements and the use of public cloud infrastructure to reduce processing capacity. McKinsey Global Institute (2019) estimated that the cost-efficiency in South Korea from digital banking services is 1.5 percent. Market-level estimate cost savings was derived based on domestic banking sector operating costs.	• McKinsey Global Institute (2017)[141]
2. SMART CONTRACTS (FINANCIAL SERVICES)		**COST SAVINGS**
Use of AI and machine learning to execute part of the functions of a contract automatically	Sized based on the cost savings in mortgage processing due to improvement in efficiency brought about by these technologies. Capgemini Consulting (2016) estimated that mortgage customers could expect a 11 to 22 percent drop in the total cost of mortgage processing fees charged to them in case smart contracts are adopted. Market-level estimate of mortgage processing costs.	• Capgemini Consulting (2016)[142]
3. ROBO ADVISORY SERVICES (FINANCIAL SERVICES)		**COST SAVINGS**
Use of robo-advisors to provide automated, algorithm-driven financial planning services based on information from clients	Sized based on the cost savings in fund management. Deloitte (2019) estimated that 27 fund management companies have seen tangible benefits since setting up their Caifu Hao accounts (robo-advisor): they have been able to increase their operational efficiency by 70 percent, while reducing their overall costs by 50 percent. Market-level estimate of cost savings was derived based on operating expenditure by fund managers in the market.	• Deloitte (2019)[143]
4. DATA ANALYTICS FOR GOVERNMENT TRANSFER PAYMENTS (GOVERNMENT)		**COST SAVINGS**
Use of data analytics in government transfer payments	Sized based on reduction in costs from using data analytics in determining eligible recipients of government transfer payments. McKinsey & Company estimated that five to ten percent of government transfer payments globally are improper payments that could be addressed by adopting data analytics. Market-level estimate was derived based on the market's GDP.	• McKinsey & Company (2017)[144]

141. McKinsey Global Institute (2019), Bracing for consolidation: The quest for scale. Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Financial%20Services/Our%20Insights/Bracing%20for%20consolidation%20in%20Asia%20Pacific%20banking%20The%20quest%20for%20scale/Asia-Pacific-Banking-Review-2019-vF.pdf
142. Capgemini Consulting (2016), Smart Contracts in Financial Services: Getting from Hype to Reality.
Available at: https://www.capgemini.com/consulting-de/wp-content/uploads/sites/32/2017/08/smart_contracts_paper_long_0.pdf
143. Deloitte (2019), Robots are here: The rise of robo-advisers in Asia Pacific.
Available at: https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/financial-services/sea-fsi-robo-advisers-asia-pacific.pdf
144. McKinsey & Company (2017), Government productivity: Unlocking the $3.5 trillion opportunity. Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Public%20and%20Social%20Sector/Our%20Insights/The%20opportunity%20in%20government%20productivity/Government-Productivity-Unlocking-the-3-5-Trillion-Opportunity-Full-report.pdf?shouldIndex=false

FINTECH - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
5. AUTOMATED BILLING AND MULTI-CURRENCY CONVERSION (PROFESSIONAL SERVICES)		**TIME SAVINGS**
Building compliance rules into automated billing processes and multi-currency conversions streamline financial calculations and run reports instantaneously	Sized based on the time savings from automated billing processes and multi-currency conversion. NetSuite (2020) estimated that automating billing processes and multi-currency conversions have helped companies to reduce staff time spent on billings by as much as 60 percent. Market-level estimate was derived based on the average hourly wage of an accountant in the market and employment size.	• NetSuite (2020)[145]

ARTIFICIAL INTELLIGENCE AND BIG DATA

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. AUTOMATION & AI CUSTOMER SERVICE IN HOTELS (CONSUMER, RETAIL & HOSPITALITY)		**INCREASED REVENUES / COST SAVINGS**
Use of AI and automated services for remote check-ins at hotels	Sized based on increased revenues from higher efficiency in hotel verification procedures. Colliers International (2019) estimates that hotel revenues could increase by ten percent through AI. The Vulcan Post reported that each hotel verification procedure typically took ten minutes. The Singapore Tourism Board estimated that the E-visitor Authentication system could eliminate manual processes and reduce check-in time by up to 70 percent. Market-level estimate was derived based on hotel revenue.	• Colliers International (2018)[146] • The Vulcan Post (2018)[147] • Singapore Tourism Board (2019)[148]
2. DATA ANALYTICS ON TRAVEL PATTERNS (CONSUMER, RETAIL & HOSPITALITY)		**INCREASED REVENUES**
Use of big data analytics in predicting consumer behaviour	Sized based on increased revenues from better targeted promotions to tourists. Boston Consulting Group (2020) estimated that brands experienced a revenue uplift of six to ten percent from integrating proprietary data to create personalised experiences. Market-level estimate was derived based on tourism revenue.	• Boston Consulting Group (2020)[149]

145. NetSuite (2020), "NetSuite Helps Talent Management Firm Streamline Financials for Continued Growth After IPO".
Available at: https://www.netsuite.com/portal/customer-testimonials/cornerstone-ondemand-software.shtml
146. Colliers International (2018), "AI and automation to increase hotel revenues by 10%."
Available at: https://www.hoteliermiddleeast.com/34362-ai-and-automation-to-increase-hotel-revenues-by-10
147. The Vulcan Post (2018), "No Queues, No Forms: this S'pore Startup Lets You Quickly Check To Hotels With A Selfie."
Available at: https://vulcanpost.com/704429/gtriip-digital-hotel-check-in-singapore/
148. Singapore Tourism Board (2019), "Industry-wide initiatives to transform hotels for sustainable growth."
Available at: https://www.stb.gov.sg/content/stb/en/media-centre/media-releases/industry-wide-initiativestotransformhotelsforsustainablegrowth.html
149. Boston Consulting Group (2020), "Bionic Revenue Management in Travel and Tourism."
Available at: https://www.bcg.com/publications/2020/bionic-revenue-management-travel-tourism

ARTIFICIAL INTELLIGENCE AND BIG DATA - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
3. E-CAREER CENTRES AND DIGITAL JOBS PLATFORMS (EDUCATION & TRAINING)	**GDP INCREMENTS**	
Use of online job listing platforms and matching of candidate profiles to available jobs based on algorithms	Sized based on GDP contributions from higher employment rate. McKinsey Global Institute (2015) estimated the impact on employment rates on different countries, stating that these were different for each market, depending on its labour market characteristics, education and income levels and demographic trends. Market-level estimate was derived based on employment rate, labour force and GDP per capita.	• McKinsey Global Institute (2015)[150]
4. PERSONALISED LEARNING (EDUCATION & TRAINING)	**GDP INCREMENTS**	
Use of digital technologies to provide personalised and remote learning opportunities for students	Sized based on increase in GDP from higher employment rate. McKinsey Global Institute (2018) estimated that personalised learning would increase employment rate by 0.5 percent in high-income countries, and 0.9 percent in other countries. Classification of the market's income level was based on the World Bank's definition. Market-level estimate was derived based on employment rate, labour force and GDP per capita.	• McKinsey Global Institute (2018)[151] • World Bank[152]
5. BIG DATA ANALYTICS (FINANCIAL SERVICES)	**INCREASED REVENUES**	
Increased lending to small and medium-sized enterprises (SMEs) at higher margins due to big data	Sized based on additional revenue generated from increased lending to SMEs at higher margins. McKinsey Global Institute (2014) estimated that lending to SMEs would increase by 16 percent to 33 percent due to big data analytics, with increased margins between 1.4 percent to 1.8 percent. Market-level estimate was derived based on annual total lending to SMEs.	• McKinsey Global Institute (2014)[153]
6. REG TECH (FINANCIAL SERVICES)	**COST SAVINGS**	
Use of AI and machine learning to automate document review, risk analysis and other repetitive compliance tasks	Sized based on the cost savings in compliance expenditure due to improvement in efficiency brought about by these technologies. Juniper Research (2017) estimated that up to 50 percent of compliance expenditure could be eliminated from adopting these technologies. Kroll (2020) indicated that compliance expenditure contributed to about five percent of banks' operating costs on average. Market-level estimate of efficiency savings was derived based on domestic banking sector costs.	• Juniper Research (2017)[154] • Kroll (2020)[155]

150. McKinsey Global Institute (2015), A labour market that works: Connecting talent with opportunity in the digital age.
Available at: https://www.mckinsey.com/featured-insights/employment-and-growth/connecting-talent-with-opportunity-in-the-digital-age
151. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future.
Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
152. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications
153. McKinsey Global Institute (2014), China's digital transformation: The Internet's impact on productivity and growth.
Available at: https://www.mckinsey.com/industries/high-tech/our-insights/chinas-digital-transformation
154. Juniper Research (2017), How Reg Tech can save banks billions.
Available at: https://www.juniperresearch.com/document-library/white-papers/how-regtech-can-save-banks-billions
155. Kroll (2020), Global Regulatory Outlook 2020. Available at: https://www.kroll.com/en/insights/publications/financial-compliance-regulation/global-regulatory-outlook-2020

ARTIFICIAL INTELLIGENCE AND BIG DATA - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
7. GEOGRAPHIC INFO. SYSTEM ENABLED TAX COLLECTION (GOVERNMENT)		**INCREASED TAX COLLECTION**
Use of big data and location-based information to improve tax collection	Sized based on the increase in tax collected from using big data and GIS-enabled services. In Brazil, the government managed to raise its Federal Tax collection by about 13 percent through adopting big data in audit corporate tax declaration. Market-level estimate was derived based on the market's tax evasion rate as a percentage of GDP relative to Brazil's.	• Bill & Melinda Gates Foundation and AlphaBeta (2018)[156]
8. DATA-BASED PUBLIC HEALTH INTERVENTIONS (HEALTH)		**GDP INCREMENTS**
Use of analytics to direct highly targeted health interventions for at-risk populations	Sized based on the economic value of reduced disability-adjusted life years (DALYs) due to timely public health interventions. McKinsey Global Institute (2018) indicated that the most significant and measurable impacts were on maternal and child health, as well as public sanitation and hygiene. It estimated a 0.4 percent reduction in DALYs for "high-income" countries, and 1.5 percent for other countries. Income of countries classified based on the World Bank's definition. Economic value was taken to be this multiplied by GDP per capita, and was estimated based on the proportion of the population suffering from chronic diseases. Market-level estimate was derived based on population sizes and GDP per capita.	• McKinsey Global Institute (2018)[157] • UN Population Division (2018)[158] • World Bank[159]
9. DETECTION OF COUNTERFEIT PHARMACEUTICAL DRUGS (HEALTH)		**COST SAVINGS**
Use of IoT and advanced analytics to detect counterfeit drugs	Sized based on cost savings from reduced counterfeit pharmaceutical drugs in the market due to higher detection rates. EU IPO (2016) estimated that the annual cost of counterfeit pharmaceutical drugs to Europe's pharmaceutical industry was EUR10 billion. McKinsey Global Institute (2013) assessed that 30 percent to 50 percent of all drugs sold were addressable by this technology, and that its success rate was between 80 percent and 100 percent. Market-level estimate on the market-specific cost of counterfeit drugs was derived based on the market's relative healthcare expenditure.	• EU Intellectual Property Office (2016)[160] • McKinsey Global Institute (2013)[161]

156. Bill & Melinda Gates Foundation and AlphaBeta (2018), Digital Innovation in Public Financial Management (PFM): Opportunities and implications for low-income countries. Available at: https://www.alphabeta.com/wp-content/uploads/2018/07/pfm-technology-paper-long-version.pdf
157. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
158. UN Population Division (2018). Available at: https://esa.un.org/unpd/wpp/DataQuery/
159. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications
160. EU Intellectual Property Office (2016), The economic cost of IPR infringement in the pharmaceutical industry. Available at: https://euipo.europa.eu/ohimportal/en/web/observatory/ipr-infringement-pharmaceutical-sector
161. McKinsey Global Institute (2013), Disruptive technologies: Advances that will transform life, business, and the global economy. Available at: https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies

ARTIFICIAL INTELLIGENCE AND BIG DATA - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
10. PREDICTIVE MAINTENANCE TECHNOLOGIES (INFRASTRUCTURE)		**COST SAVINGS**
Using data from sensors to ensure prompt and predictive maintenance, minimizing downtime	Sized based on the economic value of benefits from sizeable applications including the predictive maintenance of public transit systems and water leakage detection and control. McKinsey Global Institute (2018) estimated a 2.3 percent reduction in average commuting time from predictive transit for "high-income" countries, and 1.4 percent for other countries. On water leakage detection and control, McKinsey Global Institute (2018) estimated a 1.4 percent reduction in water consumption for "high-income" countries, and market-level estimates were used in other countries. Classification of the market's income level was based on the World Bank's definition. The Business and Sustainable Development Commission (2017) estimated that the global average price of water was USD0.90/m3. Market-level estimate was derived based on the market's average commuting time, population, GDP per capita and domestic water consumption.	• McKinsey Global Institute (2018)[162] • World Bank[163] • UNESCO-IHE (2011)[164] • Business and Sustainable Development Commission (2017)[165]
11. BIG DATA ANALYTICS (MANUFACTURING)		**INCREASED REVENUES**
Use of big data analytics in demand forecasting and supply planning	Sized based on increase in revenue from more accurate demand-supply matching leading to higher sales. McKinsey (2017) estimated a four percent to ten percent increase in profit margin from big data analytics in manufacturing. Market-level estimate was derived based on domestic manufacturing sector GDP.	• McKinsey (2017)[166]
12. DATA VISUALISATION AND ANALYTICS DASHBOARDS (PROFESSIONAL SERVICES)		**INCREASED REVENUES / COST SAVINGS**
Use of data visualisation and analytics dashboards to visualise complex business problem in a way that allows customers, suppliers and operations teams to make decisions based on data insights	Sized based on the estimated productivity impacts from using data visualisation dashboards, such as Tableau. Tableau (2020) estimated that an outsourcing and consulting group streamlined reporting by ten hours per week and increased operational productivity by 25 percent. Market-level estimate was derived based on the operating expenditure in the sector.	• Tableau (2020)[167]

162. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future.
Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
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165. Business and Sustainable Development Commission (2017), Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth.
166. McKinsey (2017), Manufacturing: Analytics unleashes productivity and profitability.
Available at: https://www.mckinsey.com/business-functions/operations/our-insights/manufacturing-analytics-unleashes-productivity-and-profitability#
167. Tableau (2020), "Workforce consulting, KellyOCG increases productivity by 25% & elevates talent to the next level with Tableau".
Available at: https://www.tableau.com/solutions/customer/kellyocgr-delivers-insight-billions-dollars-labor-spend

ARTIFICIAL INTELLIGENCE AND BIG DATA - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
13. NATURAL LANGUAGE PROCESSING (PROFESSIONAL SERVICES)	**TIME SAVINGS**	
Use of natural language processing to streamline the research process by directing researchers to specific phrases that appear in lengthy court decisions and researchers can quickly decide which cases are relevant	Sized based on the time savings from using natural language processing in legal research. National Legal Research Group (2018) estimated that attorneys using AI-powered legal research platforms finished research projects on average 24.5 percent faster than attorneys using traditional legal research. Market-level estimate was derived based on the average hourly wage of a legal researcher in the market and employment size.	• National Legal Research Group (2018)[168]
14. AUTONOMOUS VEHICLES (TRANSPORT SERVICES)	**COST SAVINGS**	
Use of AI and sensors to increase fuel efficiency	Sized based on the projected gains in fuel efficiency, compared to conventional vehicles. IEEE Intelligent Transportation Systems Magazine (2019) estimated that autonomous cars could travel more closely together, reducing air resistance and improving fuel efficiency by five percent to seven percent. Market-level estimate was derived based on the number of cars, projected number of autonomous vehicles, annual fuel requirement, and cost of fuel.	• IEEE Intelligent Transportation Systems Magazine (2019)[169]
15. GEOSPATIAL SERVICES (TRANSPORT SERVICES)	**PRODUCTIVITY GAINS / COST SAVINGS**	
Productivity impact of using location-based information	Sized based on estimated productivity impact geospatial services in the transport sector (land, sea and air). AlphaBeta (2017) estimated that geospatial services could improve productivity of land, sea and air transport by 2.5 percent to five percent. These benefits include reduced logistics costs, improved network design and management. Market-level estimate was derived based on the size of the land, sea and air transport sector.	• AlphaBeta (2017)[170]

168. National Legal Research Group (2018), The real impact of using artificial intelligence in legal research.
Available at: https://www.lawsitesblog.com/wp-content/uploads/sites/509/2018/09/The-Real-Impact-of-Using-Artificial-Intelligence-in-Legal-Research-FINAL2.pdf
169. IEEE Intelligent Transportation Systems (2019), An Automated Vehicle Fuel Economy Benefits Evaluation Framework Using Real-World Travel and Traffic Data.
Available at: https://ieeexplore.ieee.org/document/8744229/authors#authors
170. AlphaBeta (2017), The Economic Impact of Geospatial Services: How Consumers, Businesses And Society Benefit from Location-Based Information.
Available at: https://www.alphabeta.com/wp-content/uploads/2017/09/GeoSpatial-Report_Sept-2017.pdf

INTERNET OF THINGS (IOT)

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. PRECISION FARMING TECHNOLOGIES (AGRICULTURE & FOOD)		**PRODUCTIVITY GAINS / COST SAVINGS**
Data-driven optimisation of crop and meat production	Sized based on the productivity gains from increased yield, as well as cost savings from the use of fewer resources in farming. The National Institute of Agricultural Science (2019) found that in a Variable Rate Treatment (VRT) plot, the average yield was 34 percent higher than the control. Market-level estimate was derived based on the effectiveness of the technology within the context of the market's agricultural landscape and its agricultural sector GDP.	• South Korea National Institute of Agricultural Science (2019)[171] • World Bank[172]
2. SUPPLY CHAIN MANAGEMENT (AGRICULTURE & FOOD)		**INCREASED REVENUES**
IoT technology to help reduce food waste in supply chain	Sized based on the additional revenues from reduced food losses that occur in the supply chain. McKinsey Global Institute (2014) estimated that ten percent to 15 percent of all food waste throughout the supply chain were recoverable from technology-enabled supply chain management. Market-level estimate was derived based on annual food waste from the supply chain which was assumed to grow at constant rates.	• McKinsey Global Institute (2014)[173] • Food and Land Use Coalition[174]
3. FOOD SAFETY TECHNOLOGIES (AGRICULTURE & FOOD)		**COST SAVINGS**
Using sensors, data monitoring and analysis techniques to ensure the biosecurity of food products and predict when concerns may arise	Sized based on cost savings from reduced food contamination losses. Fast Company (2017) reported that improving food traceability via sensing, tracking and data monitoring technologies could improve the percentage of food arriving at the retailers' premises with target freshness, from 30 percent to 90 percent. PricewaterhouseCoopers (2015) and FSNS (2020) estimated the global cost of food fraud, proxied by lost sales due to adverse health consequences, to be between USD30 billion to USD50 billion a year. Growth in cost of food fraud was derived based on FAO's estimate of global food demand growth. Market-level estimate of food contamination losses was derived based on the relative share of global GDP.	• Fast Company (2017)[175] • PricewaterhouseCoopers (2015)[176] • FSNS (2020)[177] • Food and Agriculture Organisation of the United Nations[178]

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178. Food and Agriculture Organisation of the United Nations (2002), "World agriculture 2030: Main findings." Available at: http://www.fao.org/english/newsroom/news/2002/7833-en.html

INTERNET OF THINGS (IOT) - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
4. IOT APPLICATIONS IN THE RETAIL INDUSTRY (CONSUMER, RETAIL & HOSPITALITY)	**PRODUCTIVITY GAINS**	
Use of IoT to optimise processes in retail	Sized based on productivity gains from automated checkouts, reduction in inventory shrinkage and inventory optimisation. McKinsey Global Institute (2015) estimated that the usage of IoT in the retail industry could generate between USD183 billion to USD493 billion globally in 2025. Market-level estimate was derived based on the share of the market's retail sales, out of global retail sales.	• McKinsey Global Institute (2015)[179]
5. REMOTE PATIENT MONITORING (HEALTH)	**COST SAVINGS**	
Application of remote monitoring systems to improve patient care	Sized based on cost savings to the healthcare system through reduced hospital visits, length of patients' stays and medical procedures. McKinsey Global Institute (2013) estimated that such systems would reduce hospital visits, length of patients' stays and number of procedures relating to chronic diseases, resulting in ten percent to 20 percent savings for the healthcare system. Market-level estimate was derived from the World Bank's estimate of total healthcare spend and the market's share of spending on chronic diseases.	• McKinsey Global Institute (2013)[180] • World Bank[181]
6. SMART MEDICAL DEVICES (HEALTH)	**GDP INCREMENTS**	
Analysing data across connected implants, smart medical devices and wearables in personalised and predictive care	Sized based on the economic value of reduced disability-adjusted life years (DALYs) due to health improvement measures prompted by data from such devices. McKinsey Global Institute (2018) estimated that smart medical devices reduced DALYs by one percent reduction in high-income countries, and 0.6 percent in other countries. The economic value was taken to be this multiplied by GDP per capita. Classification of the market's income level was based on the World Bank's definition. Market-level estimate was derived based on population sizes and GDP per capita, and was estimated based on the proportion of the population suffering from chronic diseases.	• McKinsey Global Institute (2018)[182] • UN Population Division (2018)[183] • World Bank[184]

179. McKinsey Global Institute (2015), The Internet of Things: Mapping the value beyond the hype. Available at: https://www.mckinsey.com/~/media/mckinsey/industries/technology%20media%20and%20telecommunications/high%20tech/our%20insights/the%20internet%20of%20things%20the%20value%20of%20digitizing%20the%20physical%20world/the-internet-of-things-mapping-the-value-beyond-the-hype.pdf
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181. World Bank statistics on current health expenditure. Available at: https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS
182. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
183. UN Population Division (2018). Available at: https://esa.un.org/unpd/wpp/DataQuery/
184. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

INTERNET OF THINGS (IOT) - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
7. SMART GRIDS (INFRASTRUCTURE)		**COST SAVINGS**
Use of digital communications technology in detecting and optimising electricity networks	Sized based on cost savings from energy savings due to lower consumption and efficiency improvements. The International Herald Tribune (2018) reported that engineers indicated a five to ten percent in energy savings from using smart grids. Market-level estimate was derived based on total electricity consumption. Business and Sustainable Development Commission (2017) estimated that the global average wholesale price of electricity was USD100/Mwh.	• The International Herald Tribune (2018)[185] • World Bank[186] • Business and Sustainable Development Commission (2017)[187]
8. SMART BUILDINGS (INFRASTRUCTURE)		**COST SAVINGS**
Use of physical sensor networks, energy storage and data analytics to improve resource efficiency of buildings and reduce energy and water consumption, as well as carbon emissions	Sized based on the economic value of the reduction in greenhouse gas emissions (GHG) and water consumption by building automation systems. McKinsey Global Institute (2018) estimated a 2.9 percent reduction in GHG emissions and a 1.7 percent reduction in water consumption for "high-income" countries. The corresponding figures for other countries were 1.4 percent and 1.1 percent. Classification of the market's income level was based on the World Bank's definition. Market-level estimate was derived based on its greenhouse gas emissions and water consumption from buildings. Business and Sustainable Development Commission (2017) estimated that the global average price of water was USD0.90/m3 and GHG price was valued at USD50/tonne (a global proxy price equating roughly to the financial incentives needed to achieve carbon emissions consistent with a 2-degree pathway).	• McKinsey Global Institute (2018)[188] • IPCC[189] • World Bank[190] • Business and Sustainable Development Commission (2017)[191]
9. IOT APPLICATIONS IN FACTORIES (MANUFACTURING)		**PRODUCTIVITY GAINS / COST SAVINGS**
Savings in operating costs and productivity gains from IoT-enabled processes in factories	Sized based on reduction in operating costs and productivity gains from adopting IoT-enabled processes in supply chain management and distribution network management. McKinsey Global Institute (2015) estimated that the usage of IoT in the manufacturing industry could generate between USD1.1 trillion to USD3 trillion globally in 2025. Market-level estimate was derived based on the share of the market's manufacturing output, out of global manufacturing output.	• McKinsey Global Institute (2015)[192]

185. The International Herald Tribune (2011), "To build a better grid".
Available at: https://www.nytimes.com/2011/07/29/business/global/to-build-a-better-grid.html?_r=1&pagewanted=all
186. World Bank statistics on electric power consumption. Available at: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC
187. Business and Sustainable Development Commission (2017), Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth.
Available at: http://businesscommission.org/our-work/valuing-the-sdg-prize-unlocking-business-opportunities-to-accelerate-sustainable-and-inclusive-growth
188. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future.
Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
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190. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications
191. Business and Sustainable Development Commission (2017), Valuing the SDG prize: Unlocking business opportunities to accelerate sustainable and inclusive growth.
192. McKinsey Global Institute (2015), The Internet of Things: Mapping the value beyond the hype. Available at: https://www.mckinsey.com/~/media/mckinsey/industries/technology%20media%20and%20telecommunications/high%20tech/our%20insights/the%20internet%20of%20things%20the%20value%20of%20digitizing%20the%20physical%20world/the-internet-of-things-mapping-the-value-beyond-the-hype.pdf

INTERNET OF THINGS (IOT) - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
10. SMART ROADS (TRANSPORT SERVICES)		**TIME SAVINGS**
Use of real-time public transit information, intelligent traffic signals and real-time road navigation to reduce commuting time	Sized based on the economic value of real-time public transit information, intelligent traffic signals and real-time road navigation. McKinsey Global Institute (2018) estimated a 2.2 percent reduction in average commuting time for "high-income" countries, and 5.5 percent for other countries. Classification of the market's income level was based on the World Bank's definition. Market-level estimate was derived based on the average commuting time, population and GDP per capita.	• McKinsey Global Institute (2018)[193] • World Bank[194]
11. SMART PORTS (TRANSPORT SERVICES)		**COST SAVINGS**
Use of IoT to enhance port efficiency	Sized based on cost savings from reduced logistics costs due to IoT-enabled data collection and monitoring, as well as intelligent decision-making capabilities. Accenture and SIPG (2016) estimated 3.6 percent savings in logistics costs from building smart ports. Market-level estimate was derived based on logistics sector costs (based on indicated percentages of the market's GDP).	• Accenture and SIPG (2016)[195] • Council of Supply Chain Management Professionals (2013)[196] • World Bank (2016)[197]

CLOUD COMPUTING

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. ONLINE RETRAINING PROGRAMMES (EDUCATION & TRAINING)		**GDP INCREMENTS**
Lifelong learning opportunities delivered in digital format helped individuals gain new skills	Sized based on increase in GDP from higher employment rate. McKinsey Global Institute (2018) estimated that online retraining programmes would increase employment rate by 0.1 percent in "high income" countries, and 0.3 percent in "middle-income" countries. Market-level estimate was derived based on employment rate, labour force and GDP per capita.	• McKinsey Global Institute (2018)[198] • World Bank[199]

193. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
194. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications
195. Accenture and Shanghai International Port Group (2016), Connected ports: Driving future trade. Available at: https://globalmaritimehub.com/wp-content/uploads/attach_926.pdf
196. Council of Supply Chain Management Professionals (2013), State of logistics report. Available at: https://www.logisticsmgmt.com/article/state_of_logistics_2013_new_order_new_opportunities
197. World Bank (2016), Logistics performance index: Ranking by countries. Available at: https://lpi.worldbank.org/international/global
198. McKinsey Global Institute (2018), Smart cities: Digital solutions for a more liveable future. Available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future
199. World Bank (2018). Available at: https://blogs.worldbank.org/opendata/new-country-classifications

CLOUD COMPUTING - CONT'D

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
2. CLOUD COMPUTING (GOVERNMENT)		**COST SAVINGS**
Use of cloud-based software to reduce costs	Sized based on the estimated savings from cloud computing, specifically in the reduction in hardware costs. InfoWorld (2019) reported that companies experienced between 25 percent to 55 percent cost savings after migrating to the cloud. Market-level estimate was derived based on government ICT expenditure and hardware costs.	• InfoWorld[200]
3. E-PROCUREMENT (GOVERNMENT)		**COST SAVINGS**
Cost savings from using e-procurement channels	Sized based on the reduction in transaction costs from shifting to e-procurement for government projects. In South Korea, the Public Procurement Service estimated that the government saved USD8 billion in transaction costs annually through reduced labour costs, reduced lead-time and a more streamlined process. Market-level estimate was derived based on public procurement volumes.	• Public Procurement Service[201]
4. ELECTRONIC MEDICAL RECORDS (HEALTH)		**COST SAVINGS**
Use of cloud-based electronic medical record systems	Sized based on the cumulative savings (such as saving of physician and nursing time) from adopting electronic health records (EHR). McKinsey Global Institute (2014) estimated that widespread adoption of electronic medical records could increase India's annual economic value by USD3 billion. The global economic impact of EHR was estimated based on India's share of the global healthcare expenditure. Market-level estimate was derived based on its relative market-specific healthcare expenditure according to World Bank data and the global EHR market growth rates.	• McKinsey Global Institute (2014)[202] • World Bank[203] • Transparency Market Research[204]
5. CLOUD-BASED FILE MANAGEMENT SERVICES (PROFESSIONAL SERVICES)		**PRODUCTIVITY GAINS / COST SAVINGS**
Use of cloud computing technology to store and organise data virtually	Sized based on estimated cost savings from reduced bandwidth costs. ITProToday (2020) estimated that a consulting firm has been able to cut bandwidth costs by 66 percent after migrating to the cloud. Market-level estimate was derived based on the IT expenditure in the sector.	• ITProToday (2020)[205]

200. InfoWorld (2019), "Can the cloud save you money? These companies say yes".
Available at: https://www.infoworld.com/article/3445206/can-the-cloud-save-you-money-these-companies-say-yes.html
201. Public Procurement Service (2012), e-Procurement Experience in Korea: Implementation and Impact.
Available at: https://www.europarl.europa.eu/document/activities/cont/201207/20120710ATT48620/20120710ATT48620EN.pdf
202. McKinsey Global Institute (2014), India's technology opportunity: Transforming work, empowering people.
Available at: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/indias-tech-opportunity-transforming-work-empowering-people
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204. Transparency Market Research (2018), "Electronic Health Records Market". Available at: https://www.transparencymarketresearch.com/electronic-health-records-market.html
205. ITProToday (2020), "ClearSky's Cloud Storage Passes Myers-Briggs' Data Management Test".
Available at: https://www.itprotoday.com/cloud-storage/clearskys-cloud-storage-passes-myers-briggs-data-management-test

MOBILE INTERNET

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. DIGITAL RETAIL SALES AND MARKETING CHANNELS (CONSUMER, RETAIL & HOSPITALITY)		**COST SAVINGS**
Reduction in costs from delivering retail goods through digital channel reducing labour, inventory, and real estate costs	Sized based on cost savings from delivering goods digitally. It is estimated that selling goods through digital channels could lead to a 17 percent reduction in cost, based on reduced labour requirements, inventory efficiencies and lower real estate costs. Market-level estimate was derived based on domestic retail sales (assuming constant growth rates).	• The Geography of Transport Systems (2020)[206]
2. ONLINE F&B DELIVERY CHANNELS (CONSUMER, RETAIL & HOSPITALITY)		**INCREASED REVENUES**
Use of online delivery service	Sized based on increase in revenues from capturing F&B orders placed online. The Straits Times (2017) reported that restaurants have seen revenues rise by 15 percent after partnering food delivery firms. Market-level estimate was derived based on domestic restaurant revenues.	• The Straits Times (2017)[207]
3. TELEHEALTH APPLICATIONS (HEALTH)		**COST SAVINGS**
Use of internet and mobile technologies for medical consultations	Sized based on cost savings to the healthcare system through reduced doctor visits. Goldman Sachs (2015) estimated that the US healthcare system could save USD100 billion by adopting telehealth. Market-level estimate was derived based on relative market-specific healthcare expenditure.	• Goldman Sachs (2015)[208]

206. Jean-Paul Rodrigue (2020, The Geography of Transport Systems Chapter 7 – Trade, Logistics and Freight Distribution 7.4 – Logistics and Freight Distribution. Available at: https://www.routledge.com/The-Geography-of-Transport-Systems/Rodrigue/p/book/9780367364632
207. The Straits Times (2017), "Delivery sales drive up eateries' revenues." Available at: https://www.straitstimes.com/business/delivery-sales-drive-up-eateries-revenues
208. Goldman Sachs (2015), The digital revolution comes to US healthcare. Available at: https://www.wur.nl/upload_mm/0/f/3/8fe8684c-2a84-4965-9dce-550584aae48c_Internet%20of%20Things%205%20-%20Digital%20Revolution%20Comes%20to%20US%20Healtcare.pdf

ADVANCED ROBOTICS

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. AUTOMATION & ROBOTICS (MANUFACTURING)		**PRODUCTIVITY GAINS**
Productivity boost from automating mundane and repetitive production tasks	Sized based on productivity boost to manufacturing processes from robots performing mundane and repetitive tasks. McKinsey & Company (2017) estimated that automation and robotics could improve productivity ranging from 0.8 to 1.4 percent of global GDP annually from 2015 to 2065. Market-level estimate was derived based on domestic manufacturing sales.	• McKinsey & Company (2017)[209]

ADDITIVE MANUFACTURING

DESCRIPTION	SIZING ASSUMPTIONS	SOURCE
1. ADDITIVE MANUFACTURING (MANUFACTURING)		**PRODUCTIVITY GAINS / COST SAVINGS**
Use of dynamic, resource efficient 3D printing and related technologies to enable 'on-time' manufacturing & rapid manufacturing	Sized based on the incremental economic value of faster time-to-market due to quicker prototyping and design adjustments, reduced production time, higher material productivity as well as more efficient sales process due to product customization. McKinsey & Company (2017) estimated that the global economic value of this technology could reach between USD100 billion and USD250 billion by 2025. Current economic value was calculated based on today's global manufacturing sector GDP, and assuming a constant growth rate for the 2030 forecast. Market-level estimate was derived based on the domestic manufacturing sector GDP as a share of the global figure.	• McKinsey & Company (2017)[210]

209. McKinsey & Company (2017), A future that works: Automation, employment, and productivity. Available at: https://www.mckinsey.com/~/media/mckinsey/featured%20insights/digital%20disruption/harnessing%20automation%20for%20a%20future%20that%20works/a-future-that-works-executive-summary-mgi-january-2017.ashx
210. McKinsey & Company (2017), Additive manufacturing: A long-term game changer for manufacturers. Available at: https://www.mckinsey.com/business-functions/operations/our-insights/additive-manufacturing-a-long-term-game-changer-for-manufacturers

B: SIZING THE VALUE OF DIGITAL SKILLS IN HONG KONG

The value of digital skills for Hong Kong was estimated based on the relevant GDP contributions from digitally skilled workers in the economy.

Given the importance of digital skills in both technology (e.g., ICT services) and non-technology sectors (e.g., manufacturing), the economic contributions of workers with digital skills throughout the economy have been assessed in this report. Three categories of workers were considered. These include:

a. Workers in the technology sector (e.g., AI developers, software developers, cloud engineers in technology or software companies);

b. Digital workers in non-technology sectors (e.g., Building Information Modelling engineers in construction companies, automation engineers in manufacturing companies); and

c. Non-digital workers in non-technology sectors who require digital skills to perform their jobs (e.g., factory workers in the manufacturing industry who require some level of IT proficiency to operate machinery).

In this report, the technology sector is defined as comprising a set of sub-sectors in which digital services are produced. The sub-sectors defined under the technology sector include the following industries under Hong Kong's "Information and Communications" sector:[211]

- Telecommunications
- Information technology service activities
- Information service activities

SIZING THE CURRENT VALUE (2020) OF DIGITAL SKILLS

CATEGORY 1: WORKERS IN THE TECHNOLOGY SECTOR

The GDP contribution from these workers was sized based on the sum of GDP contributions from the constituent sub-sectors of the technology sector. This breakdown is available in government statistics, and the 2020 figures were projected based on applying the historical 5-year CAGRs of each technology sub-sector to the published 2019 figures.[212]

CATEGORY 2: DIGITAL WORKERS IN NON-TECHNOLOGY SECTORS

The economic value of the digital skills of workers in technology-related occupations in Hong Kong's non-technology sectors (termed "digital workers") was sized based on the sum of their GDP contributions. Similar to workers under Category 1, workers' full GDP contributions were included since digital skills are essential for them to perform their jobs.

211. This set of sub-sectors is similar to those identified in AlphaBeta's 2019 report, Australia's digital opportunity, which sized the economic contribution of Australia's technology sector. See: AlphaBeta (2019), Australia's digital opportunity. Available at: https://digi.org.au/wp-content/uploads/2019/09/Australias-Digital-Opportunity.pdf/ List of subsectors for Hong Kong retrieved from Census and Statistics Department, The Government of the Hong Kong Special Administrative Region (2020). Available at: https://www.censtatd.gov.hk/hkstat/un/class/hsic/index.jsp

212. Census and Statistics Department, The Government of the Hong Kong Special Administrative Region (2020). Available at: https://www.censtatd.gov.hk/hkstat/un/class/hsic/index.jsp

As detailed information on digital jobs and skills are not available from government statistics, online job portal data was used to derive proxies for the share of workers in each sector with technology-related or digital jobs. Job listings across different sectors were collected from Recruit Hong Kong, a Hong Kong job portal.[213] For each sector, technology-related job titles were filtered out of the general sample of job postings, using keyword searches.[214] The underlying assumption is that online job postings form a representative sample of job listings in the industry, which in turn gives a representative picture of employment needs by occupation in the industry.

CATEGORY 3: NON-DIGITAL WORKERS APPLYING DIGITAL SKILLS AT WORK IN NON-TECHNOLOGY SECTORS

The economic value of the digital skills of non-digital workers who apply digital skills in their jobs in non-technology sectors was sized based on a proportion of their GDP contributions. The economic value is not equivalent to the total GDP contribution per worker as the economic contribution of such workers are not derived entirely from digital skills - a proportion of this will come from their non-digital skills. Rather, digital skills are additive to workers' other skills, i.e., they enhance workers' productivity and this additional GDP contribution generated is the economic value that digital skills provide.

However, in order to establish the additional productivity benefits from digital skills, the baseline total GDP contribution of these workers needs to be established first. In the absence of detailed data on digital skills in the working population by sector from government statistics, job portal data was again used to derive proxies for the share of workers in each sector who apply digital skills in their jobs.[215] For each sector, job listings with digital skill requirements were filtered using keyword searches applied to the required skills stated for the listings.[216]

To correct for any possible overestimation of the shares of digitally skilled workers since job portal data is a representation of labour demand, the derived shares were compared against existing estimates available for Hong Kong from third-party sources. To avoid any double counting issues, the share of non-digital workers who apply digital skills at work was derived by subtracting the share of workers with digital jobs from the share of workers who apply digital skills at work – for each sector. To ensure that only the relevant proportion of these workers' GDP contributions (i.e. the additional GDP generated from digital skills) are captured (since not all of their economic output is linked to digital skills), a ratio based on the incremental labour productivity that could be achieved due to digital skills was applied to the full GDP contributions. According to a 2017 study by Burning Glass Technologies, jobs that require baseline digital skills pay a 17 percent premium over equivalent non-digital roles.[217] The underlying assumption in this methodology is that wage premiums accorded to digital skills are equal to the incremental improvement in labour productivity that could be achieved due to digital skills.

213. The job portal used for the analysis is Recruit HK (See: Recruit HK. Available at: https://www.recruit.com.hk) This job portal was selected due to its high number of job listings across a wide range of sectors, as compared to other job portals in Hong Kong, as well as the large number of data points available for each industry sector. A total number of 9,121 listings (for full-time, Hong Kong-based jobs) was analysed. The job listings analysed were for both fresh graduates and mid-career professionals.
214. Keywords include: "ICT", "online", "web", "graphic", "data", "digital", "AI", "artificial intelligence", "machine learning", "UI design", "UX design", "Internet", "sensor", "software development", "software design", "IT engineer", "cloud", "programmer", "mobile marketing", "mobile design", "e-commerce", "5G", "electronics engineer", "electrical engineer", "telecommunications engineer", "systems analyst", "IoT", "automation", "automate", "application", "information systems", "IT manager", "IT consultant", "developer", "social media" and "technology".
215. The job portal used for the analysis is Recruit HK (See: Recruit HK. Available at: https://www.recruit.com.hk) This job portal was selected due to its high number of job listings across a wide range of sectors, as compared to other job portals in Hong Kong, as well as the large number of data points available for each industry sector. A total number of 9,121 listings (for full-time, Hong Kong-based jobs) was analysed. The job listings analysed were for both fresh graduates and mid-career professionals.
216. Keywords include: "ICT", "online", "computer", "data", "programming", "software", "IT skills", "technology", "information technology", "digital", "graphic", "AI", "artificial intelligence", "machine learning", "UI design", "UX design", "Internet", "sensor", "cloud", "e-commerce", "5G", "PowerPoint", "coding", "IoT", "technology", "Excel", "PC", "CAD", "illustrator", "photoshop", and "information".
217. Burning Glass Technologies (2017), The digital edge: Middle-skill workers and careers.
Available at: https://www.burning-glass.com/wp-content/uploads/Digital_Edge_report_2017_final.pdf

EXHIBIT B1:

THE ECONOMIC VALUE OF DIGITAL SKILLS IN THE TECHNOLOGY SECTOR IS SIZED BASED ON THE GDP CONTRIBUTIONS FROM WORKERS IN THIS SECTOR

CALCULATION OF THE VALUE OF DIGITAL SKILLS (2020)

Category of workers		Key inputs	Data sources
GDP contribution from workers in tech sector in 2020	=	GDP contribution from sub-sectors under the tech sector	Government statistics
GDP contribution from digital workers in non-tech sectors in 2020	=	% of workers with digital jobs by sector	Job portal data
		×	
		Total number of workers by sector	Government statistics
		×	
		Sector-specific labour productivity	Government statistics
GDP contribution from non-digital workers with digital skills in non-tech sectors in 2020	=	Share of non-digital jobs requiring digital skills in non-tech sectors	Job portal data
		×	
		Number of workers in non-tech sectors	Government statistics
		×	
		Sector-specific labour productivity	Government statistics
		×	
		% increase in labour productivity due to digital skills	Burning Glass Technologies (2017)

SOURCE: AlphaBeta analysis

SIZING THE FUTURE (2030) VALUE OF DIGITAL SKILLS

To size the future value of digital skills, it was assumed that Hong Kong matched the performance seen in global leaders for digital skills in 2030 (under an "Accelerated" scenario). As reflected in Exhibit B2, for each category of workers, a global leader was selected. To ensure that the global leader is of a comparable size with Hong Kong, only high-income markets with a GDP of at least 60 percent of Hong Kong's GDP were considered.[218] Exhibit B2 also shows the metric in the global leaders that was utilised to model the figures for Hong Kong.

EXHIBIT B2:

TO DERIVE THE VALUE UNDER THE "ACCELERATED" SCENARIO IN 2030, HONG KONG IS ASSUMED TO MATCH THE PERFORMANCE OF GLOBAL LEADERS FOR DIGITAL SKILLS

	Select global leader of comparable size[1]	Assume Hong Kong catches up to global leader and project 2030 value
	Characteristic used to determine global leader	**Calculation of Hong Kong's 2030 "Accelerated" scenario value**
#1 GDP contribution from workers in tech sector	Highest share of GDP contribution from tech sector (Source: OECD) Global leader: Sweden[2]	Assume Hong Kong matches Sweden's current tech sector share of GDP (Source: Government statistics)[2]
#2 GDP contribution from digital workers in non-tech sectors	Highest average share of businesses employing ICT specialists across non-tech sectors (Source: OECD) Global leader: Ireland[3]	Assume number of digital workers in each of Hong Kong's non-tech sectors grow to 2030 based on historical 5-year CAGR of number of ICT specialists in Ireland[3] (Source: OECD)
#3 GDP contribution from digital workers in non-tech sectors	Highest average share of workers who use computers regularly at work across non-tech sectors (Source: OECD) Global leader: Finland[4]	Assume same share of workers with digital skills (i.e., use computers regularly) in each non-tech sector in Hong Kong as in Finland in 2030, and subtract respective shares of digital workers derived from #2[4] (Source: OECD)

1. This refers to high-income markets with GDP size of at least 60% of Hong Kong's GDP.
2. Of high-income markets with 2018 GDP size of 60% of Hong Kong's in the OECD database, Sweden has the highest share of GDP contribution coming from its ICT sector at 4.9% in 2018. In comparison, Hong Kong's tech sector share of GDP is 2.7%. Under the "Accelerated" scenario, Hong Kong was assumed to exhibit Sweden's current tech sector share of GDP at 4.9% in 2030.
3. Of high-income markets with 2018 GDP size of 60% of Hong Kong's in the OECD database, Ireland has the highest average share of businesses employing ICT specialists across non-tech sectors at 32.9% in 2018. In comparison, Hong Kong's was 8% in 2019 (based on job portal data; figure for Hong Kong not available in the OECD database). Hong Kong was assumed to exhibit Ireland's historical 5-year growth rate in the number of digital workers at 4% per annum.
4. Of high-income markets with 2018 GDP size of 60% of Hong Kong's in the OECD database, Finland has the highest average share of workers who use computers regularly at work across non-tech sectors at 77.5% in 2017. In comparison, Hong Kong's was 61% in 2019 (based on job portal data; figure for Hong Kong not available in the OECD database). Hong Kong was assumed to exhibit the same shares of digitally skilled workers in Finland's non-tech sectors in 2018.
SOURCE: AlphaBeta analysis

218. Based on the World Bank's classification of countries by income level for 2019-2020. See: World Bank. Available at: http://blogs.worldbank.org/opendata/new-country-classifications-income-level-2019-2020

C: SIZING GOOGLE'S ECONOMIC IMPACT IN HONG KONG

To estimate the **business benefits**, the economic value generated by businesses that used Google's products was calculated. These are in the form of increased revenue (through increased customer outreach and access to new markets), as well as improved productivity (through time savings). The Google products included in this analysis of business benefits include Google Search, Google Ads, AdSense, YouTube and Google Play.

To estimate **societal benefits**, the resultant revenue gains experienced by Hong Kong businesses from the use of Google Ads, AdSense, and YouTube was then used to calculate the job creation benefits indirectly supported by Google.

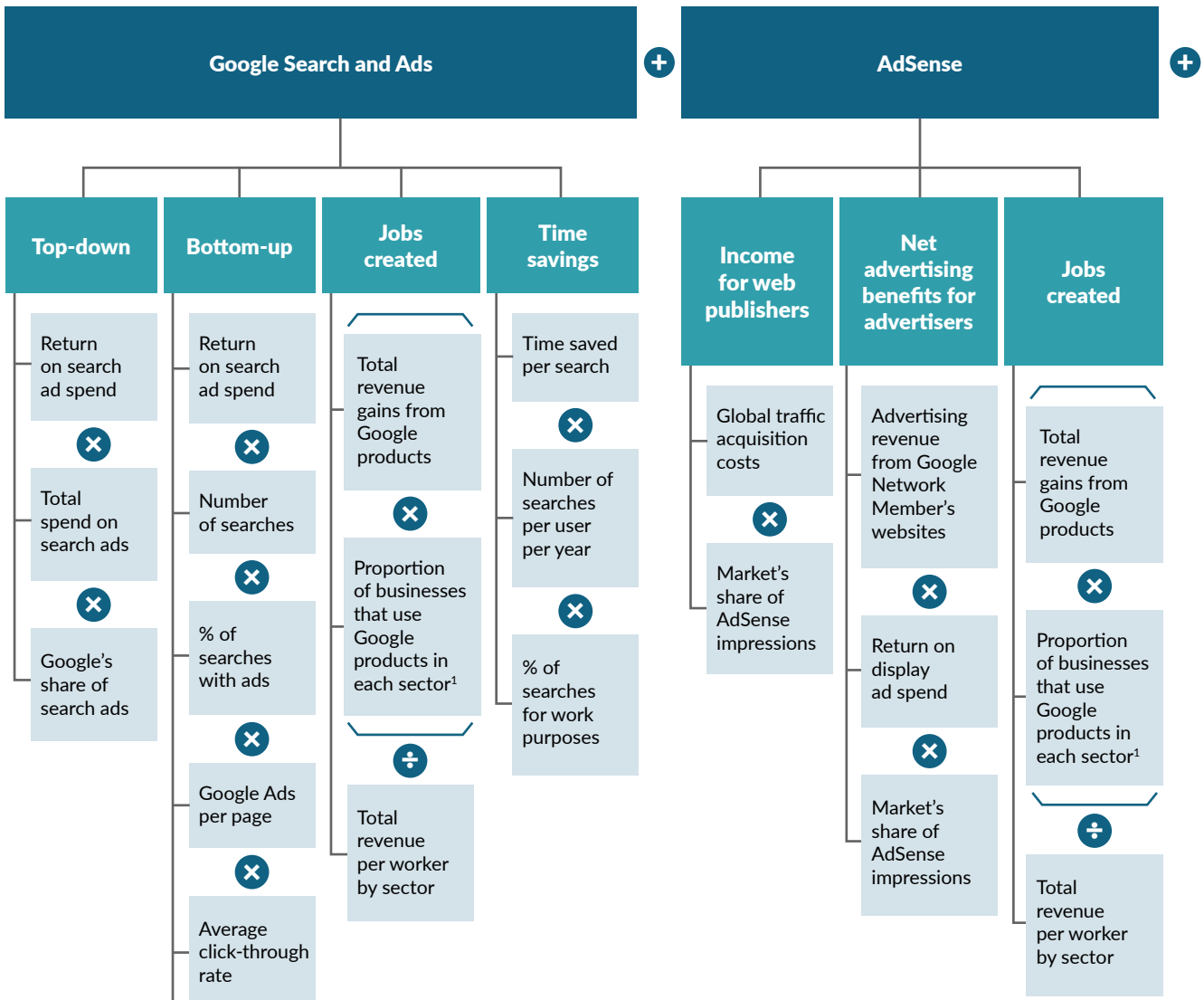
Estimating the **consumer benefits** supported by Google is a challenging task. This is because individuals typically do not have to pay for the Google products that they use. There are several established methodologies for estimating the benefits of free services, including consumer surplus based on the consumer's willingness to pay (how much an individual values a Google product). Primary data used in the analysis was collected from a consumer survey of 531 Internet users in Hong Kong. This sample size is statistically significant based on Hong Kong's online population, at a 95 percent confidence level (the level typically adopted by researchers). The survey was conducted online, which was deemed suitable given the intention to survey internet users. The sample was also checked for its representativeness of Hong Kong's Internet population based on demographic variables including age, income level, and the geographical location of respondents. The Google products included in this analysis of consumer benefits include Google Search, Google Play, YouTube, Google Drive, Photos, Docs, and Sheets.

BUSINESS AND JOB CREATION BENEFITS

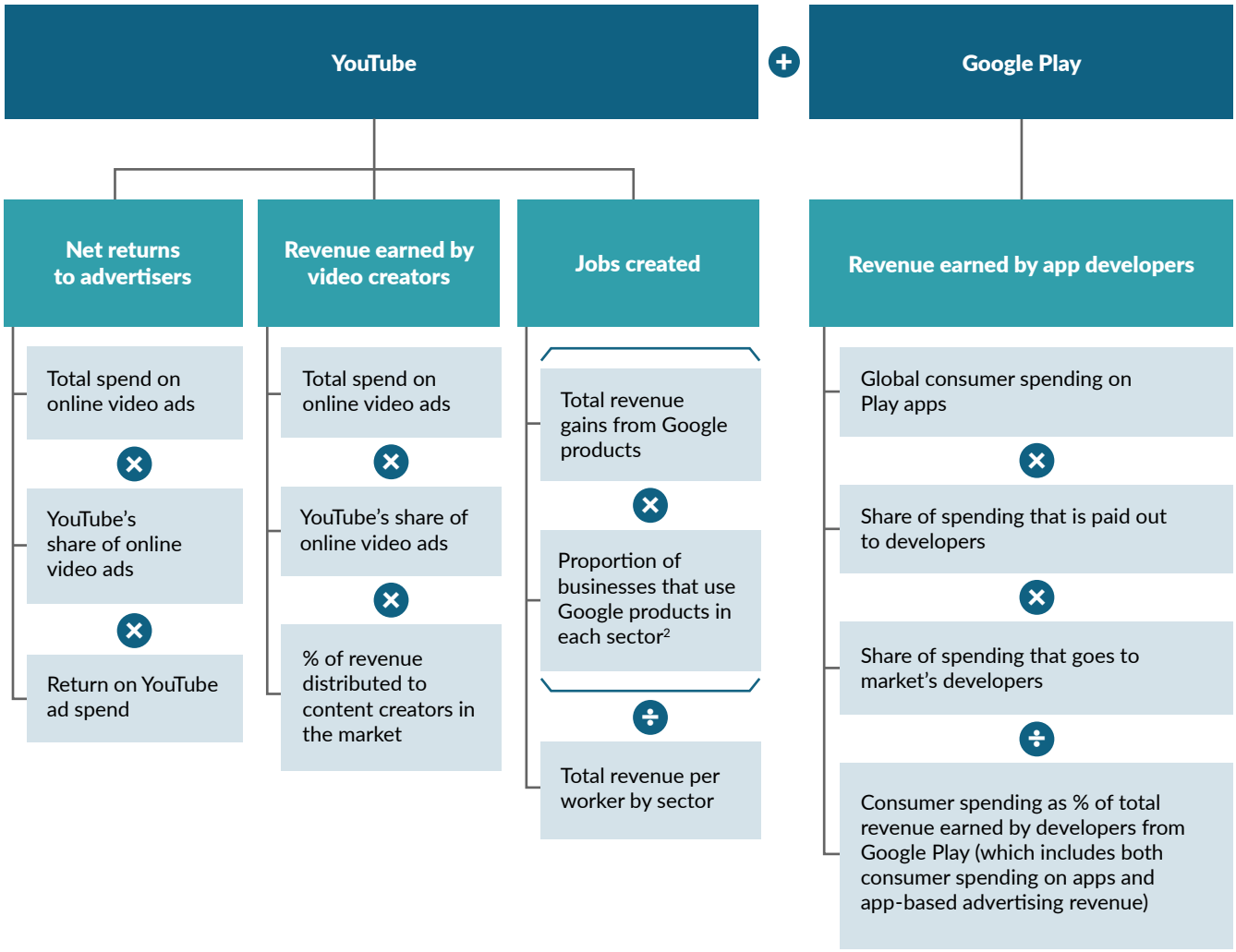
The business benefits supported by Google include the gross revenue, income or savings generated by businesses using Google products. These benefits do not include the flow-on economic effects generated, such as further purchases from their suppliers or the economic activity generated by the employees of these businesses who spend their wages in the broader economy. These benefits also do not account for activity that may have been displaced by Google, nor attempt to estimate the incremental impact of Google on the Hong Kong economy beyond what would be the case if Google did not exist but other companies like it did. Exhibit C1 summarises the methodology used for sizing the business benefits of Google's products, as well as the job creation benefits.

EXHIBIT C1:

METHODOLOGY FOR SIZING BUSINESS AND JOB CREATION BENEFITS FROM GOOGLE



1. In the absence of such publicly available data, this was proxied based on the proportion of businesses that use websites in each sector. This data is available from Census and Statistics Department of Hong Kong (2019), Report on the Survey in Information Technology Usage and Penetration in the Business Sector for 2019.
Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1110005/att/B11100052019BE19B100.pdf
2. In the absence of such publicly available data, this was proxied based on the proportion of businesses that use a social media account in each sector. This data is available from Census and Statistics Department of Hong Kong (2019), Report on the Survey in Information Technology Usage and Penetration in the Business Sector for 2019.
Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1110005/att/B11100052019BE19B100.pdf
Note: This report's methodology for measuring Google's economic impact is consistent with the methodology used in the Google Economic and Social Impact South Korea and New Zealand 2021 reports.
SOURCE: AlphaBeta analysis


YouTube
Google Play
Net returns to advertisers
Revenue earned by video creators
Jobs created
Revenue earned by app developers
Total spend on online video ads
YouTube's share of online video ads
Return on YouTube ad spend
Total spend on online video ads
YouTube's share of online video ads
% of revenue distributed to content creators in the market
Total revenue gains from Google products
Proportion of businesses that use Google products in each sector[2]
Total revenue per worker by sector
Global consumer spending on Play apps
Share of spending that is paid out to developers
Share of spending that goes to market's developers
Consumer spending as % of total revenue earned by developers from Google Play (which includes both consumer spending on apps and app-based advertising revenue)

GOOGLE SEARCH AND ADS

The business benefits of Google Search and Ads were estimated using two methods – a top-down approach and a bottom-up approach. The top-down approach estimated the total size of the search advertising segment in the market and the proportion of this space that Google represents. The bottom-up approach estimated the number of Google searches conducted in the market, the proportion of searches with advertisements, the number of advertisements per search, the average click-through rate (CTR), and the average cost-per-click (CPC).

To estimate the income generated by businesses paying for online advertising through Google a return on investment (ROI) ratio range of 3.4 – 8 was applied, and both estimates were reported.[219] This ROI ratio was developed from a few assumptions:

- Using a large sample of proprietary data, Hal Varian, Google's Chief Economist, estimated that businesses received USD2 in revenue for every USD1 spent on advertising. This finding was published in the American Economic Review in 2009.

- Businesses also receive free clicks because of unpaid Google Search. Using research published in the International Journal of Internet Marketing and Advertising in 2009 by Jansen and Spink, the Google US Economic Impact Study assumed that businesses receive five clicks for every click on a paid advertisement.

- Unpaid clicks are not considered as commercially valuable, so the US Economic Impact Study assumed their value at 70 percent of paid clicks.

- Because of these assumptions, an ROI ratio of 8 was estimated. This ROI ratio was taken as an upper bound. To derive a lower bound, we built on the academic findings detailed in the Google UK Economic Impact Study to set a lower bound of 3.4.

Table 2 shows the inputs and sources used for estimating the business benefits of Google Search and Ads.

ADSENSE

The direct business benefits from AdSense were estimated as the net advertising benefits generated by businesses placing advertisements on publisher sites such as websites, blogs, and forums.[220] We estimated this figure using Google's published global advertising revenue from Google network's websites and multiplied this by the market's share of global AdSense impressions.[221] In addition, we applied an ROI ratio that advertisers earn using display advertising, derived from academic literature.

The benefits of AdSense to content creators were also estimated as the total income that they earn from placing advertisements sourced through Ads next to content on their website. The total income earned by the market's content creators was estimated from Google's global payments to website publishers, also known as their traffic acquisition costs, and applying the market's share of AdSense impressions to estimate the payments specific to the market.

Table 3 shows the inputs and sources used for estimating the business benefits of AdSense.

YOUTUBE

We estimated the direct benefits of YouTube to video advertisers in the market based on the total video advertising spend in the market and YouTube's share of that market. This estimate was then multiplied with the ROI ratios for YouTube advertisement. Table 4 shows the inputs and sources used for estimating the business benefits of YouTube

219. ROI reflects the net advertising benefits that businesses receive from online advertising (i.e., total revenue minus online advertising cost).
220. This refers to the increase in revenues and sales that can be directly attributed to advertising minus the related advertising expenditure.
221. This methodology does not account for price differences across markets due to the lack of availability of reliable data on cost per impression by market.

TABLE 2: INPUTS AND SOURCES FOR CALCULATING BUSINESS BENEFITS OF GOOGLE SEARCH AND ADS

APPROACH	METRIC	SOURCE
Top-down approach	Total market expenditure on search advertising	• Statista (2019)[222]
	Google Search's market share	• StatCounter (2019)[223]
Bottom-up approach	Google Search traffic data	• AlphaBeta Consumer Survey (2020)
	% pages that display advertisements	• Varian (2009)[224], Jansen & Spink (2009)[225] • Deloitte (2015)[226]
	Advertisements per page on average	• Varian (2009)[227], Jansen & Spink (2009)[228] • Deloitte (2015)[229]
	CTR for Search (Estimate)	• Word Stream (2019)[230] • BannerTag (2019)[231]
	Average CPC for Search (Estimate)	• Word Stream (2018)[232] • Adstage (2019)[233]
Both Methods	ROI ratio Lower and Upper Bound	• Varian (2009)[234], Jansen & Spink (2009)[235] • Deloitte (2015)[236]

222. Statista (2019), "Search advertising – Hong Kong". Available at: https://www.statista.com/outlook/dmo/digital-advertising/hong-kong
223. StatCounter (2019), "Search engine market share Hong Kong". Available at: https://gs.statcounter.com/search-engine-market-share/all/hong-kong
224. Varian, H. R. (2009), "Online Ad Auctions". The American Economic Review, Vol. 99, No. 2, pp. 430-434.
225. Jansen, B. J., & Spink, A. (2009), "Investigating customer click through behaviour with integrated sponsored and non-sponsored results." International Journal of Internet Marketing and Advertising, Vol. 5, No. 1-2, pp. 74-94.
226. Deloitte (2015), Google's Economic Impact United Kingdom.
227. Varian, H. R. (2009), "Online Ad Auctions". The American Economic Review, Vol. 99, No. 2, pp. 430-434.
228. Jansen, B. J., & Spink, A. (2009), "Investigating customer click through behaviour with integrated sponsored and non-sponsored results." International Journal of Internet Marketing and Advertising, Vol. 5, No. 1-2, pp. 74-94.
229. Deloitte (2015), Google's Economic Impact United Kingdom.
230. Laubenstein, C. (2019), "What's a Good Click-Through Rate (CTR) for Google Ads?". Word Stream. Available at: https://www.wordstream.com/blog/ws/2010/04/26/good-click-through-rate
231. Karlštrems, A. (2019), "Google AdSense CPM Rates 2019". BannerTag. Available at: https://www.bannertag.com/google-adsense-cpm-rates/
232. Irvine, M. (2018), "Average Cost per Click by Country: Where in the World Are the Highest CPCs?" Word Stream. Available at: http://www.wordstream.com/blog/ws/2015/07/06/average-cost-per-click
233. Adstage (Q3 2019), Paid media - benchmark report. Available at: https://cdn2.hubspot.net/hubfs/4350015/Benchmark%20Report/Q3%202019%20Paid%20Media%20Benchmark%20Report.pdf
234. Varian, H. R. (2009), "Online Ad Auctions". The American Economic Review, Vol. 99, No. 2, pp. 430-434.
235. Jansen, B. J., & Spink, A. (2009), "Investigating customer click through behaviour with integrated sponsored and non-sponsored results." International Journal of Internet Marketing and Advertising, Vol. 5, No. 1-2, pp. 74-94.
236. Deloitte (2015), Google's Economic Impact United Kingdom. Available at: https://www.valueoftheweb.com/reports/googles-economic-impact-united-kingdom-2014/

TABLE 3: INPUTS AND SOURCES FOR CALCULATING BUSINESS BENEFITS OF ADSENSE

ESTIMATION	METRIC	SOURCE
Net advertising benefits for advertisers	Advertising revenue from Google Network Member's websites	• Alphabet (2019)[237]
	ROI ratio	• Gupta et al. (2015)[238]
Revenue to content creators	Global traffic acquisition costs related to AdSense	• Alphabet (2019)[239]
Both estimates	Market share of global impressions on AdSense (Estimate)	• DoubleClick (2012)[240] • Internet World Stats (2019)[241]

TABLE 4: INPUTS AND SOURCES FOR CALCULATING BUSINESS BENEFITS OF YOUTUBE

METRIC	SOURCE
Total video advertising spend in Hong Kong	• Statista (2019)[242]
YouTube's market share	• AlphaBeta Consumer Survey (2020)
YouTube ROI ratio	• Business Insider (2014)[243]

TIME SAVINGS BENEFITS OF GOOGLE SEARCH

We estimated the time saving benefits that businesses gained from using Google Search based on the amount of time saved per search, the number of searches conducted per worker, and the share of searches that were conducted for work purposes.

Table 5 shows the inputs and sources used for estimating the time savings benefits of Google Search.

JOB CREATION BENEFITS FROM GOOGLE PRODUCTS

We estimated the number of jobs that are indirectly supported through revenue gains experienced by Hong Kong businesses from the use of Google's products for advertising. These include revenue gains from Google Ads, AdSense and YouTube. The underlying principle here is that as businesses gain increased revenue as they market their goods and services more effectively through the use of these Google services, their businesses expand and they will need to hire more employees to support the increased demand. This is a conservative estimate as it does not include "spillover jobs" such as new jobs that get created in the supply chain - e.g., supplier companies that also require to hire more as they sell an increased level of raw materials or component services to these businesses. To estimate the job creation impacts robustly, these were computed at the sectoral level, based on the breakdown of Google-supported revenue

237. Alphabet (2019). Form 10-K for fiscal year ended December 31, 2019 - Submission to US SEC.
Available at: https://www.sec.gov/Archives/edgar/data/1652044/000165204420000008/goog10-k2019.htm
238. Gupta, S., Pauwels, K., & Kireyev, P. (2015), Do display ads influence search? Attribution and dynamics in online advertising. International Journal of Research in Marketing.
239. Alphabet (2019). Form 10-K for fiscal year ended December 31, 2019 - Submission to US SEC.
Available at: https://www.sec.gov/Archives/edgar/data/1652044/000165204420000008/goog10-k2019.htm
240. Google DoubleClick (2012). What's trending in display for publishers?.
Available at: https://www.slideshare.net/RFONNIER/display-business-trends-publisher-edition-google-2012
241. Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers".
Available at: https://www.internetworldstats.com/asia.htm
242. Statista (2020), "Video advertising – Hong Kong". Available at: https://www.statista.com/outlook/dmo/digital-advertising/video-advertising/hong-kong
243. Business Insider (2016), "Google attacks TV".
Available at: https://www.businessinsider.com.au/youtube-ads-have-better-roi-than-tv-according-to-google-2016-4

gains by sector, and revenue per worker in each sector. The breakdown of these Google-supported revenue gains by sector was estimated based on the average of the following two metrics: 1) share of businesses using websites (to proxy for the use of Google Ads as well as AdSense) or the share of businesses with social media accounts (to proxy for the use of YouTube) by sector; and 2) revenues of businesses in each sector. The total revenue gains supported by Google's advertising products in each sector was then divided by the respective revenue per worker figures for each sector to obtain the number of jobs indirectly supported by Google in each sector. The total number of jobs indirectly supported by Google in Hong Kong's economy was taken as a sum of the estimated job creation benefits across all sectors. Table 6 shows the inputs and sources used for estimating the job impact.

TABLE 5: INPUTS AND SOURCES FOR CALCULATING TIME SAVING BENEFITS OF GOOGLE SEARCH

METRIC	SOURCE
Time saved per search	• Varian (2014)[244] • Chen et al. (2014)[245]
Average daily searches per worker	• AlphaBeta Consumer Survey (2020)
% of searches for work purposes	• AlphaBeta Consumer Survey (2020)

TABLE 6: INPUTS AND SOURCES FOR CALCULATING JOB IMPACT

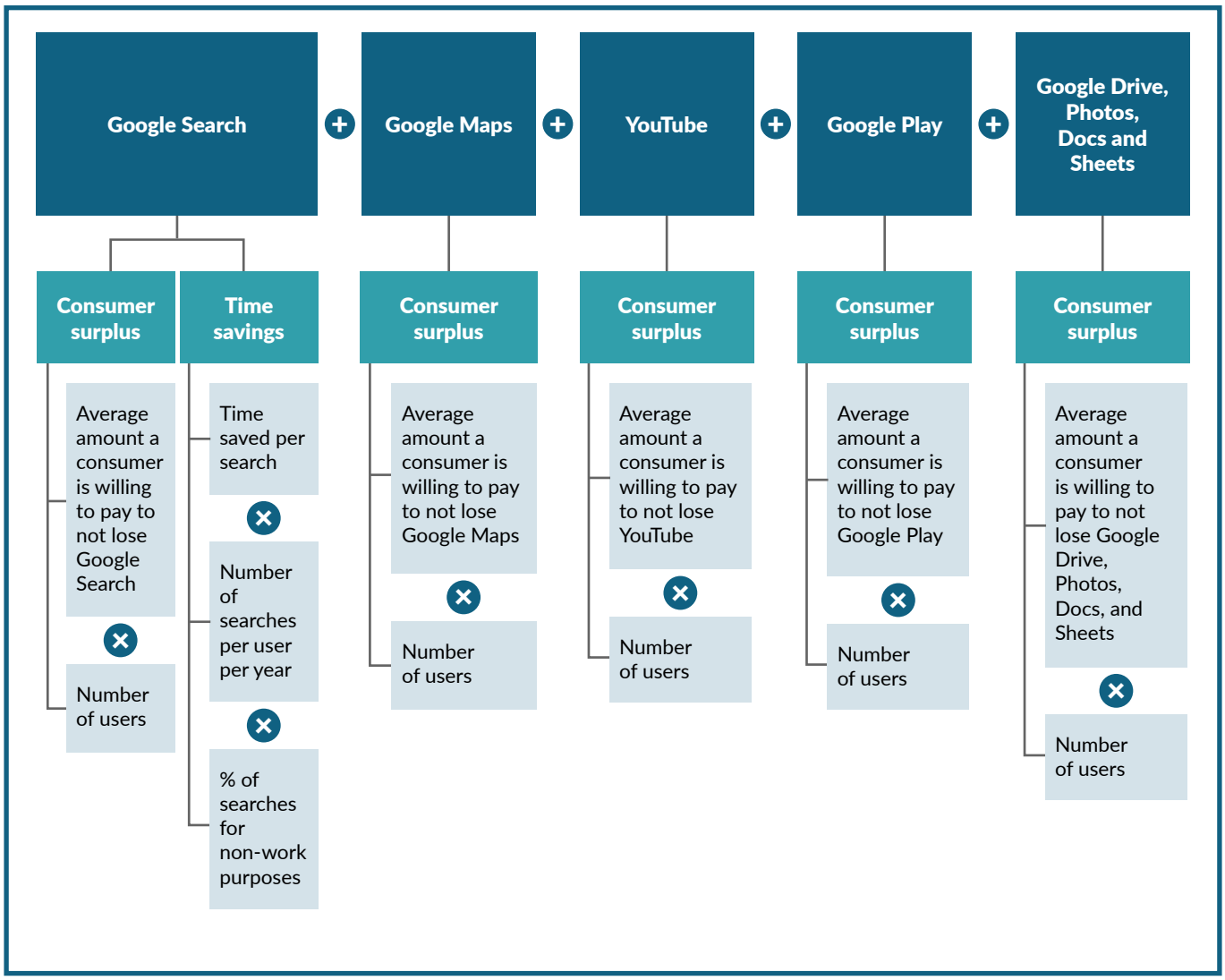
APPROACH	METRIC	SOURCE
Revenue per worker by sector	Number of employees in Hong Kong by sector	• Census and Statistics Department of Hong Kong (2021)[246]
	Total revenue by sector	• Census and Statistics Department of Hong Kong (2021)[247]
Breakdown of business benefits for Google Ads, AdSense and YouTube	Businesses using a website from each sector as % of total	• Census and Statistics Department of Hong Kong (2019)[248]
	Businesses with a social media account as % of total	• Census and Statistics Department of Hong Kong (2019)[249]

244. Hal Varian (2014), "Economic value of Google" (Presentation).
Available at: http://cdn.oreillystatic.com/en/assets/1/event/57/The%20Economic%20Impact%20of%20Google%20Presentation.pdf
245. Chen, Y., YoungJoo Jeon, G., & Kim, Y.-M. (2014), "A day without a search engine: an experimental study of online and offline searches". Experimental Economics, Vol 17, Issue 4, pp 512-536.
246. Census and Statistics Department of Hong Kong (2021), "Number of establishments and persons engaged (other than those in the Civil Service) analysed by industry section".
Available at: https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=D5250011&scode=452
247. Census and Statistics Department of Hong Kong (2020), Hong Kong Annual Digest of Statistics.
Available at: https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1010003&scode=460
248. Census and Statistics Department of Hong Kong (2019), Report on the Survey in Information Technology Usage and Penetration in the Business Sector for 2019.
Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1110005/att/B11100052019BE19B100.pdf
249. Census and Statistics Department of Hong Kong (2019), Report on the Survey in Information Technology Usage and Penetration in the Business Sector for 2019.
Available at: https://www.censtatd.gov.hk/en/data/stat_report/product/B1110005/att/B11100052019BE19B100.pdf

CONSUMER BENEFITS

The consumer benefits supported by Google are challenging to measure and calculate because individuals typically do not pay for the services. In the absence of price indicators, we adopted the economic "willingness to pay" principle to estimate the value of consumer benefits by asking individuals how much they value specific products – also known as consumer surplus. We also calculated the time savings accrued to consumers from their use of Google Search (which increases the efficiency of information gathering). Exhibit C2 summarises the methodology used for sizing consumer surplus and time savings of relevant products.

EXHIBIT C2:
METHODOLOGY FOR SIZING CONSUMER BENEFITS FROM GOOGLE



Note: This report's methodology for measuring Google's economic impact is consistent with the methodology used in the Google Economic and Social Impact South Korea and New Zealand 2021 reports.
SOURCE: AlphaBeta analysis

GOOGLE SEARCH

We estimated the benefits of Google Search to consumers using two metrics: consumer surplus and time savings.

To calculate the consumer surplus for Google Search, we multiplied the number of Google Search users with the average willingness to pay obtained from the consumer survey.

To calculate time savings, we applied time saving estimates from an experiment that measured the time taken to conduct a search online versus a search at the library.[250] This study found that a search that takes 21 minutes in the library takes seven minutes online. After accounting for the fact that people now ask more questions due to the ease of online search, we estimated the time saved across the market by using Google Search.

The share of Google Search users in the market who have made use of Google Search for self-enrichment purposes such as learning new skills or acquiring knowledge in a new topic was also estimated using the consumer survey.

Table 7 shows the inputs and sources used for calculating the consumer benefits of Google Search.

GOOGLE MAPS

We sized the benefits of Google Maps to consumers using willingness to pay, where consumers were asked to value their favourite online maps service. To calculate the consumer surplus for Google Maps, we multiplied the number of Google Maps users with the average willingness to pay obtained from the consumer survey.

Table 8 shows the inputs and sources used for calculating the consumer benefits of Google Maps.

GOOGLE PLAY

We calculated the benefits of Google Play to consumers using willingness to pay, where consumers were asked to value their favourite online distribution platform for digital products. Results from the survey of the market's online population were used.

Table 9 shows the inputs and sources used for calculating the consumer benefits of Google Play.

GOOGLE DRIVE, PHOTOS, DOCS, AND SHEETS

We calculated the benefits of Google Drive, Photos, Docs, and Sheets to consumers using willingness to pay, where consumers were asked to value their favourite online cloud-based file storage and document collaboration service. Results from the survey of the market's online population were used.

Table 10 shows the inputs and sources used for calculating the consumer benefits of Google Drive, Photos, Docs, and Sheets.

YOUTUBE

We calculated the benefits of YouTube to consumers using willingness to pay, where consumers were asked to value their favourite online video service. Results from the survey of the market's online population were used.

Table 11 shows the inputs and sources used for calculating the consumer benefits of YouTube.

250. Chen et al. (2014) A day without a search engine: an experimental study of online and offline searches. Experimental Economics, Vol 17, Issue 4, pp 512-536.

TABLE 7: INPUTS AND SOURCES FOR CALCULATING CONSUMER BENEFITS OF GOOGLE SEARCH

ESTIMATION	METRIC	SOURCE
Consumer surplus	Amount that consumers value product per year (WTP)	• AlphaBeta Consumer Survey (2020)
	Online Population (OP)	• Internet World Stats (2019)[251]
	Search users as % of OP	• AlphaBeta Consumer Survey (2020)
Time saved per user	Time saved per search	• Varian (2014)[252] • Chen et al. (2014)[253]
	Average daily searches per user	• AlphaBeta Consumer Survey (2020)
	% of searches for non-work purposes	• AlphaBeta Consumer Survey (2020)
Share of Search users who have made use of Search for self-enrichment purposes	% of Search users in Hong Kong who made use of Search for self-enrichment purposes	• AlphaBeta Consumer Survey (2020)

TABLE 8: INPUTS AND SOURCES FOR CALCULATING CONSUMER BENEFITS OF GOOGLE MAPS

ESTIMATION	METRIC	SOURCE
Consumer surplus	Amount that consumers value product per year (WTP)	• AlphaBeta Consumer Survey (2020)
	Online Population (OP)	• Internet World Stats (2019)[254]
	Map users as % of OP	• AlphaBeta Consumer Survey (2020)

TABLE 9: INPUTS AND SOURCES FOR CALCULATING CONSUMER BENEFITS OF GOOGLE PLAY

ESTIMATION	METRIC	SOURCE
Consumer surplus	Amount that consumers value product per year (WTP)	• AlphaBeta Consumer Survey (2020)
	Online Population (OP)	• Internet World Stats (2019)[255]
	Google Play users as % of OP	• AlphaBeta Consumer Survey (2020)

251. Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers".
Available at: https://www.internetworldstats.com/asia.htm
252. Hal Varian (2014), "Economic value of Google" (Presentation).
Available at: http://cdn.oreillystatic.com/en/assets/1/event/57/The%20Economic%20Impact%20of%20Google%20Presentation.pdf
253. Chen, Y., YoungJoo Jeon, G., & Kim, Y.-M. (2014), "A day without a search engine: an experimental study of online and offline searches". Experimental Economics, Vol 17, Issue 4, pp 512-536.
254. Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers".
Available at: https://www.internetworldstats.com/asia.htm
255. Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers".
Available at: https://www.internetworldstats.com/asia.htm

TABLE 10: INPUTS AND SOURCES FOR CALCULATING CONSUMER BENEFITS OF GOOGLE DRIVE, PHOTOS, DOCS, AND SHEETS

ESTIMATION	METRIC	SOURCE
Consumer surplus	Amount that consumers value product per year (WTP)	• AlphaBeta Consumer Survey (2020)
	Online Population (OP)	• Internet World Stats (2019)[256]
	Google Drive users as % of OP	• AlphaBeta Consumer Survey (2020)

TABLE 11: INPUTS AND SOURCES FOR CALCULATING CONSUMER BENEFITS OF YOUTUBE

ESTIMATION	METRIC	SOURCE
Consumer surplus	Amount that consumers value product per year (WTP)	• AlphaBeta Consumer Survey (2020)
	Online Population (OP)	• Internet World Stats (2019)[257]
	YouTube users as % of OP	• AlphaBeta Consumer Survey (2020)
Share of YouTube users who have made use of YouTube to learn advanced digital skills	% of YouTube users in Hong Kong who made use of YouTube to learn advanced digital skills	• AlphaBeta Consumer Survey (2020)

256. *Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers". Available at: https://www.internetworldstats.com/asia.htm*
257. *Internet World Stats (2019), "Asia Marketing Research, Internet Usage, Population Statistics and Facebook Subscribers". Available at: https://www.internetworldstats.com/asia.htm*

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