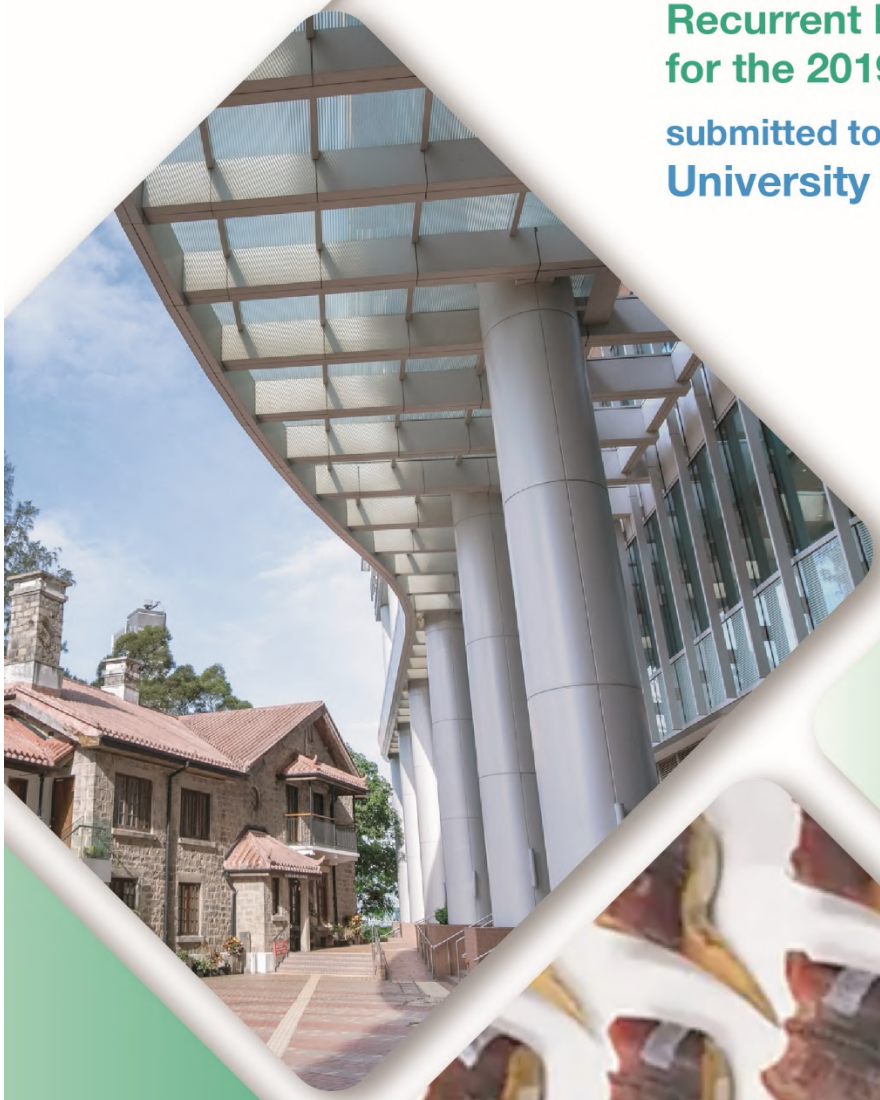
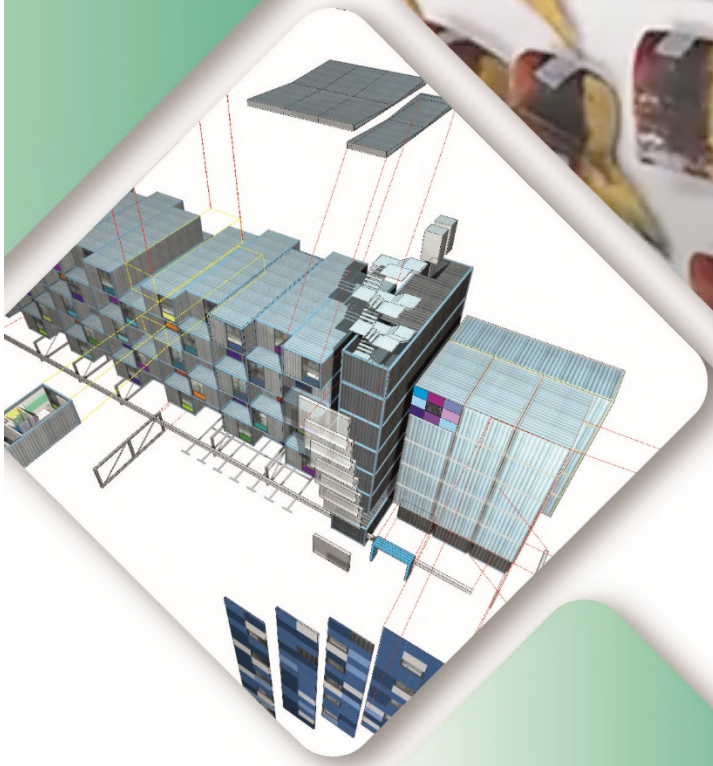
ANNUAL REPORT 2019/20

Recurrent Funding for Knowledge Transfer for the 2019/20 to 2021/22 Triennium

submitted to

University Grants Committee





香 港 大 學

THE UNIVERSITY OF HONG KONG

October 2020

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EXECUTIVE SUMMARY

Knowledge Exchange (KE) is at the bedrock of The University of Hong Kong (HKU) and is espoused as one of the pillars that underpin all the activities. Capitalising on our research prowess, HKU is committed to enhancing KE and the impact of research on the community through community engagement. We seek to translate evidence-based research outcomes to benefit stakeholders from industries, practitioners and professional bodies, to schools, non-governmental organisations, and individuals.

The reporting period of 2019/20 was another rewarding year for the KE work of HKU. Despite the protests and outbreak of COVID-19, the KE efforts of the Knowledge Exchange Office (KEO) and the Faculties had not been thwarted. We had adapted and continued our efforts. The Interdisciplinary Quick Talks, launched in 2018/19, were organised to promote interdisciplinarity and to share evidence-based knowledge on challenging issues. Participants included government officials, technology companies, schools and other institutions.

The Faculty KE Awards and the prestigious university-level KE Excellence Award, which aim to recognise significant and exceptional KE impact of HKU academic staff, were organised in the year and continued to receive encouraging responses with high quality entries. A few exemplary winning entries have been highlighted in this report. These projects had gone beyond HKU to benefit various sectors, influenced policy formulation, shaped industry practices, and in some cases led to tangible impact such as reductions in illegal trade of wildlife. The KE Excellence Award 2019, which was adjudicated in January 2020, was presented to Professor Zhiwen Chen and his team for their remarkable achievements in KE in relation their research, including contribution to the government's strategic plan on HIV, community education, development of vaccine for HIV-1, and the establishment of a biomedical start-up in Hong Kong.

The Impact Project Funding Scheme, now an important enabler for HKU academic staff to embark on KE projects with the broader community, received over 80 proposals with 57 supported. Various types of projects involving all the Faculties were involved. Two projects, with one on copyright issues in the education sector and the other about the impact of mobile dental service programme, are outlined in this report to illustrate the breadth and depth of the KE projects undertaken.

Turning to innovation and technology transfer, the Technology Transfer Office (TTO) had continued to promote and market HKU's impactful research inventions. In 2019/20, 24 HKU start-up companies received funding support totalling $8 million under the 2019/2020 Technology Start-up Support Scheme for Universities (TSSSU@HKU). The year also saw the official opening of HKSTP-HKU iAXON, a collaboration between the Hong Kong Science and Technology Parks Corporation

and HKU to aid and nurture deep technology start-ups and spin-offs from HKU. Located in the Western District and just a stone's throw from HKU campus, iAXON is well-poised to foster commercialisation of deep technology start-ups and contribute to the diversification of Hong Kong's economy. Two successful cases of HKU spin-offs are outlined in this report to demonstrate the stellar achievements of HKU start-ups.

HKU's work on KE technology transfer cannot be better illustrated by the various efforts to combat COVID-19 in 2019/20. The HKU team developed a vaccine candidate based on a previously established flu-based DelNS1 live attenuated influenza virus (LAIV) platform, while TTO has been exploring opportunities with the industry to develop the core components of protective gears and surgical face mask based on novel nanofabrication materials from the research of the Department of Civil Engineering. Rapid nucleic acid amplication tests, developed by the HKU Li Ka Shing Faculty of Medicine, have been used in over 40 countries. A HKU startup company has made its digital research tool available to universities and colleges worldwide free of charge to support e-learning activities of students at all levels.

In the year iDendron had hosted over 80 HKU students and alumni startup teams and organised more than 30 events, workshops and sharing sessions by startup founders. This report highlights the key programmes of iDendron

Strengthening research communication skills of research postgraduate students will hone the KE skills of our next generation researchers. The Visualise Your Thesis initiative and the Three Minute Thesis (3MT) Competition were organised successfully in Q2/Q3 2020 and received encouraging responses. They provided invaluable training and exposure for young and promising researchers to learn the skills relating to KE.

1. DEEPENING INSTITUTIONAL CAPACITY FOR REALISING AND CORROBORATING IMPACTFUL RESEARCH

The year 2019/20 was another fruitful year for KE. Steadfast progress had been made to roll out various measures according to the vision enshrined in HKU Vision 2016 – 2025. KE, together with Teaching and Research, form the three pillars that underpin all the activities of HKU. With the University's mission fully entrenched to create positive impact on the society, the Knowledge Exchange Office (KEO) had supported the impact agenda for the University through various activities on multiple fronts. Under the steer of the University's senior management, KEO had supported a wide range of activities and programmes undertaken by our faculty members, benefiting the general public as well as stakeholders in various sectors.

The year also saw the arrival of Dr Yiwu He as the new Director of the KEO, TTO and iDendron. In addition to his leadership role in KEO, Dr He is also HKU's Chief Innovation Officer and Senior Advisor to the President. Prior to assumption of office, Dr He held senior executive roles including the deputy director and senior program officer at the Bill & Melinda Gates Foundation, Senior Vice President and Global R&D Head at BGI, Global Head of Human Biomarker Centers at GlaxoSmithKline, board director of P4 Medicine Institute, USA, as well as the chair professor at The University of Science and Technology of China.

1.1 Interdisciplinary Quick Talks

Interdisciplinary Quick (IQ) Talks is a HKU KE series launched by KEO in February 2019 to promote interdisciplinarity and to share evidence-based knowledge on challenging issues from multiple perspectives with the community.

Two IQ Talks were organised in 2019/20. 'Animals Make a Better World" was successfully held on July 16, 2019 at HKU with over 100 participants from different sectors including government departments, institutions, secondary schools, and technology companies.

The following talks were delivered by HKU researchers at the event:

- ***Conservation Forensics @ HKU***
  Dr David Baker, School of Biological Sciences, Swire Institute of Marine Science

- ***Animal Welfare – Importance in Biological Research***
  Dr Kelvin To, Department of Microbiology

- ***Wildlife Crime and Animal Victims: Improving Access to Justice in Hong Kong***
  Ms Amanda Whitfort, Department of Professional Legal Education

- ***The Welfare of Animals in Animal-assisted Interventions***
  Dr Paul Wong, Department of Social Work and Social Administration

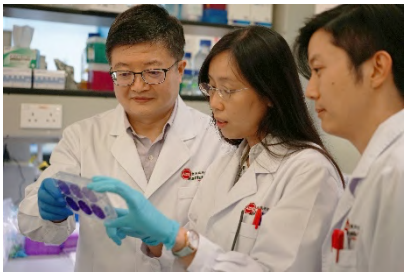
This event provided an opportunity for the HKU researchers to share with the public their views and project outcomes on how animals could make a better world in innovative ways. It also provided a forum for discussion on new ideas for interdisciplinary research and possible further KE opportunities.

The IQ Talk with the theme "Health and the City" was originally planned to be held on February 19, 2020. In view of the outbreak of COVID-19, this IQ Talk was postponed. As this topic is more relevant than ever given the salient public health issues involved in tackling pandemics and epidemics, a new date will be announced in due course. A virtual talk is planned for early 2021.

1.2 KE Awards

The 5th round of the university-level KE Excellence Award and 9th round of the Faculty KE Award Schemes were organised in the year. Both award schemes aim to recognise significant and exceptional KE impact of HKU academic staff and they continued to receive encouraging responses with high quality entries. The five examples described below are among those recognised in the KE Excellence Award and Faculty KE Award Schemes in 2019/20.

Knowledge Exchange on HIV/AIDS to Promote HIV Prevention and Care



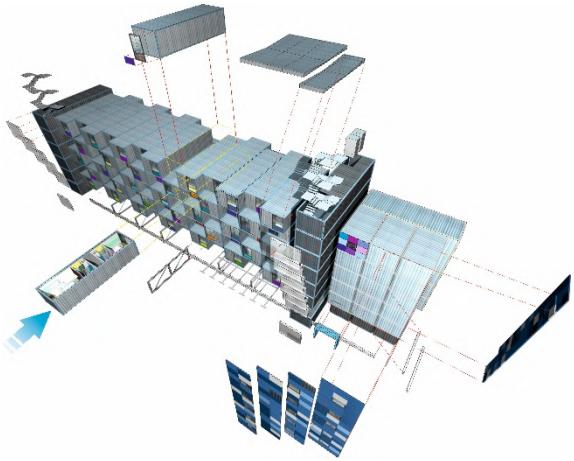
Professor Zhiwen Chen and his team have promoted Treatment as Prevention for HIV since 2009 and made contributions to the Strategic Plan and HIV Manual of the Government of the Hong Kong Special Administrative Region (HKSAR).

During the past decade, the research project has achieved significant impacts in multiple. In respect of government policies and guidelines, the research has contributed to the government's strategic plan and HIV manual. On public awareness, the research has provided evidence-based new knowledge on HIV. As regards community education, it has educated thousands of local youths, students and NGOs about HIV and its treatment. The research has also contributed to biomedical industry development. A Hong Kong biomedical company (Immuno Cure Ltd) was established based on the scientific discoveries from the research.

Professor Chen and his research team presented the discovery of PD1-based vaccine for HIV-1 immunotherapy, which has led to multiple high impact publications, a patent by HKU, improved HIV awareness, better community education, a biomedical startup company Immuno Cure in Hong Kong, and the subsequent success of the 2018/2019 TRS grant for the vaccine clinical development.

Professor Zhiwei Chen and his team received the University's KE Excellence Award 2019 for this project. More details are at Annex I-A.

Modular Integrated Construction (MiC) for Building of Higher Quality, Productivity and Sustainability in Hong Kong



Dr Wei Pan in the Department of Civil Engineering developed a new approach and disruptively innovative solutions which contributed to policy and research on, as well as practice of, design and construction of high-rise buildings in Hong Kong with higher quality, improved productivity and better sustainability.

Dr Pan's study has contributed significantly to government policy and strategy on MiC, academic and applied research, training and learning in government and the industry, public engagement, MiC pilot projects implementation, and knowledge dissemination. Examples of impact include: co-created the basis for a new policy announced in the Policy Address of the government and a strategy paper on MiC; facilitated industry transformation; receiving sizeable grants from the Research Grants Council (RGC), government and industry; and provided expert advice, support and training to the government and important industries stakeholders.

Dr Pan received the Faculty KE Award 2019 of the Faculty of Engineering. More details are at Annex I-B.

Influencing Drug Policies and Well-being of Drug Users in Hong Kong and East and Southeast Asia

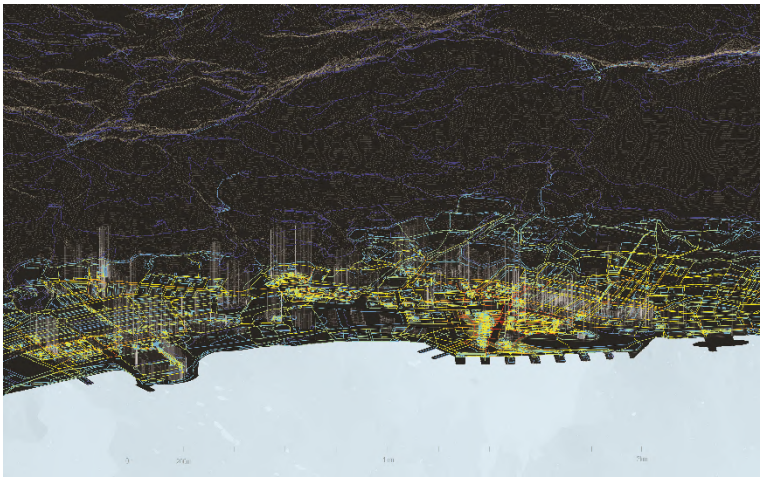
Professor Karen Laidler's project successfully demonstrates a strong evidence of impact, with her research excellence manifested in identifying and focusing on shifts in drug use prevalence and preference in Hong Kong's context. Her research findings are highly recognised by both the academia and practitioners.

Her expert witness testimony in 2005 about ketamine and ecstasy for the case of *HKSAR v Hii Siew-Cheng* led to the establishment of separate guidelines for the two drugs by the Court of Appeal in 2007, which have been cited in nearly 700 cases on drug trafficking. The impact generated from her expertise and evidence-based research was further acknowledged and evident following an invitation from the Court of Appeal to provide updates on drug abuse trend and expert evidence for a case in 2017. The importance of her expertise in the formulation and structure of sentencing guidelines for offenders of drug trafficking in ketamine is well recognised and her expert opinions are respected. The training offered to professional practitioners and close collaboration with NGOs in improving community drug treatment services in Hong Kong are also exemplary practices in public engagement for KE

projects.

Professor Laidler received the Faculty KE Award 2019 of the Faculty of Social Sciences. More details are at Annex I-C.

Spatial Design Network Analysis (sDNA) Improving Evidence-Based Urban Planning and Design Across Discipline Nationally and Worldwide



HKU Faculty of Architecture's next generation spatial design network analysis software (sDNA) has contributed to making urban spaces more sustainable in some of the world's most dynamic and dense cities. In Shanghai, Paris, London and Hong Kong, urban designers have used HKU's sDNA software to generate analytical evidence in arguing for more pedestrian- and walking-orientated space in their designs. It is estimated that the sDNA-enabled projects by Mr Alain Chiaradia and his team in the Faculty of Architecture had benefitted up to 5 million residents by offering viable well-planned walkable alternatives to car use.

Mr Alain Chiaradia received the Faculty KE Award 2019 of the Faculty of Architecture. More details are at Annex I-D.

Reduction of Illegal Global Wildlife Trade Through Novel Conservation Forensics Research

The annual illegal trade of protected wildlife is estimated to be worth US$5 billon to US$20 billion globally, with demand originating largely from Asia. As many of these illegal wildlife activities have been linked to other criminal activities, identifying and restricting this trade is of global concern. Research focusing on wildlife trade in the School of Biological Sciences at HKU encompasses over a decade of multidisciplinary work with impacts that have successfully influenced policy and increased protection for species.

Conservation actions stemming from Dr Dingle's research resulted in increased

protection of turtles, pangolins and fish under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and through the International Union for Conservation of Nature (IUCN). Newly developed forensics techniques had uncovered criminal activities and supported successful prosecutions. The research has led to significant reductions in illegal trade.

Dr Dingle received the Faculty KE Award 2019 of the Faculty of Science. More details are at Annex I-E.

1.3 Impact Project Funding Scheme

The University continued to run the annual Impact Project Funding Scheme in 2019/20, which has become an important enabler for our academic staff to benefit the broader community with their expert knowledge. In the reporting year, 83 proposals were received, of which 57 were supported. The list of the projects supported with brief information about their impact is available at the KEO website at www.ke.hku.hk/assets/doc/Impact_Project_Summary_201920_online_eng.pdf. Two completed projects are highlighted below.

Evaluating the Impact of the Mobile Dental Service Program on Community Residents

Dental service is neither accessible nor affordable to many underprivileged people in Hong Kong. An oral health survey conducted in Hong Kong reported that 75% 5-year old children had never had any dental visit while 60% 35 to 44-year old adults and 77.7% 65 to 74-year old non-institutionalised elders did not seek any regular dental checkup.

Dr Walter Lam of the Faculty of Dentistry has been paying attention to Hong Kong residents' oral health and worked to increase their access to dental service. Dr Lam noted that hitherto few studies had focused on assessing the impact of mobile oral health service programmes on recipients.

In this study, a comprehensive and in-depth evaluation was conducted regarding the mobile dental services provided through HKU's KE project "Smiley Action Days" for Hong Kong residents. The study has helped reveal residents' perspectives and views on the on-going dental services, as well as identify both enabling factors and barriers in executing the project.

Promoting Creative and Ethical Use of Copyright Works in Education

Miss Alice Lee of the Faculty of Law has been teaching and researching copyright law for more than 20 years. This project has helped promote creative and ethical use of copyright works in teaching and learning through a series of short videos on the basics of copyright law, exceptions and practices that are relevant to the entire

educational sector.

This project has helped the education sector gain a better understanding of the copyright principles and exceptions that they need in order to promote, explore and implement e-learning and other innovative teaching and learning. Copyright is meant to encourage creativity by conferring exclusive rights on authors and enabling copyright owners to make profits by distributing or licensing copyright works. In practice, the copyright regime is so complex and technical that many of its rules and exceptions are obscure or even contrary to common sense.

2. TECHNOLOGY TRANSFER AND PARTNERSHIPS WITH INDUSTRY

The Technology Transfer Office (TTO) has had active participation in technology transfer activities in order to promote and market HKU's impactful research inventions. To develop close ties with HKU research community and the industry while assisting the community in a smooth transition from research to commercialisation, TTO offers a broad perspective on questions pertinent to marketability, funding sources, industrial partners, patenting and other intellectual property issues, new business start-ups, HKU policies and procedures, and more.

2.1 Events and Promotions

2.1.1 TSSSU@HKU

TSSSU@HKU Award Presentation x Launch of Incubation Program 2019

On July 29, 2019, TTO announced in an award ceremony that 24 HKU start-up companies received funding support totaling HK$8 million under the 2019/2020 Technology Start-up Support Scheme for Universities (TSSSU@HKU). Each start-up received an annual funding of up to HK$1.5 million for a maximum of three years to support basic expense including company establishment and operations, research and development, publicity and commercialisation, as well as sale of products and services.

Professor Andy Hor, Former Vice-President and Pro-Vice-Chancellor (Research), HKU; Professor Holliday Ian, Vice-President and Pro-Vice-Chancellor (Teaching and Learning), HKU; Dr S. C. Kim, the Former Director of Technology Transfer Office, HKU; Ms Zorina Wan, Assistant Commissioner for Innovation and Technology (Policy and Development) of the Innovation and Technology Commission (ITC); Mr Peter Yan, CEO of Cyberport; and representatives from the Hong Kong Science Park (HKSTP) attended the ceremony.

2.1.2 Visit to Jiangsu

Following a delegation visit from the Jiangsu Department of Science and Technology to HKU in July 2019, HKU TTO was invited by the Jiangsu government to participate in the Jiangsu-Hong Kong Development Summit. Representatives from the Jiangsu government, industrial partners, commercial and education sectors congregated in Nanjing to discuss potential opportunities for collaboration and to witness the signing of projects between the two parties.

On November 2, 2019, TTO colleagues, together with ZIRI director, had a meeting with government officials from Jiangsu province and Nanjing municipal government. During the meeting, representatives from Jiangsu expressed interests in developing a Jiangsu-HKU innovation platform with TTO in order to link up the innovation sources from HKU with industry requirements from Jiangsu. A new special fund for Hong Kong, Macao and Taiwan related to collaboration is now under negotiation between governments. It is hoped that the approval of this fund will help lay a foundation for future collaboration with a view to further promoting innovation.

On the same day, TTO staff also attended the 2nd Jiangsu-Hong Kong Summit on Interconnected Development where they learnt about the latest industrial and commercial collaboration between Jiangsu and Hong Kong, as well as opportunities derived from the Belt and Road Initiative.

After the Nanjing trip, both HKU TTO and ZIRI colleagues took a side trip to the Suzhou Industrial Park (SIP) to visit the Dushu Lake Science and Education Innovation District on November 4, 2019. They explored several Chinese centres of overseas institutions and high-tech companies inside SIP and learnt about the operational and international technology transfer experience from the institutes, while also establishing connections with high-tech industry in SIP.

2.1.3 Financial Modelling Workshop

In 2019/20, we were delighted to have with us again Mr. Douglas Keith Abrams, Founder and CEO of Expara and Expara IDM Ventures. His workshop, titled Financial Modelling and Venture Capital, elucidated how entrepreneurs were able to 1) develop a business strategy that optimised product/market fit; and 2) build a financial model that demonstrated the financial potential of a company. Some of the specific skills developed in this workshop included: techniques in preparing business plans, business strategy, financial modelling and valuation, pitching techniques, as well as fundraising options, sources in financing startups.

Two sessions were organised, with one on 24 October 2019 and the other on 7 November 2019. In particular, the workshop was made as a prerequisite for all applicants of TSSSU@HKU Programme and iDendron Incubation Programme.

2.2 Strategic Partnership

The Official Opening of iAXON

Industry–university collaborations have been in the limelight. A start-up hub is a quintessential example of an academia-industry alliance model which aims to facilitate the process of commercialisation and explore the determinants of success for interfirm collaboration.

The Hong Kong Science and Technology Parks Corporation (HKSTP) and HKU announced on April 8, 2020 the official opening of HKSTP-HKU iAXON (iAXON), the HKSTP Western District Hub. iAXON would serve as a platform to aid and nurture deep technology start-ups and spin-offs from HKU. iAXON is a 4,000 square feet facility located at Pacific Plaza, 410 Des Voeux Road West, in the Western District, adjacent to the HKU campus. The facility houses deep technology start-ups founded by HKU students, faculty members, staff and alumni who plan to translate their academic research and innovations to business opportunities.

Dr Yiwu He, Chief Innovation Officer and Senior Advisor to the President of HKU, said, "We are grateful that HKSTP is keen to partner with HKU to create an innovative environment for deep technology start-ups. Commercialisation of first-class research at HKU will not only create a financial return that will provide more resources for better research, it will also support the development of career opportunities for young people and new high-tech industries, which will increase the diversity of Hong Kong's economy. HKU will continue to work with its partners to expand the scope of such translational efforts."

2.3 Achievements of HKU Spin-offs

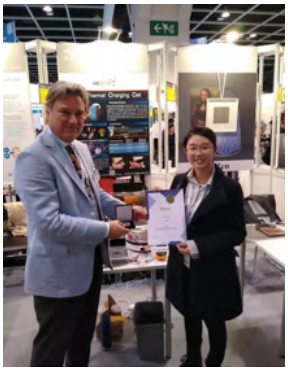
Two HKU DreamCatcher Companies Won Gold and Silver Prizes at the 2nd Asia Exhibition of Inventions Hong Kong

Two HKU start-up companies, RaSpect Intelligence Inspection Limited and High Performance Solution Limited, won a gold and a silver prize respectively at the Second Asia Exhibition of Inventions Hong Kong (AEI). AEI is an exhibition cum competition exclusively devoted to inventions from Asia where all awards are

handpicked by a panel of veteran venture capitalists, investors and specialists.

The two start-ups were awardees of the HKU DreamCatcher 100K, an entrepreneurship seed fund scheme launched by HKU to support students and young graduates to explore their startup ventures. RaSpect Intelligence Inspection Limited won a gold award with its self-developed AI Inspection Technology. The technology is intended for application in the architecture industry to improve the safety of architectures and reduce potential economic and human losses. The company was an awardee of the HKU DreamCatcher 100K in 2017.

High Performance Solution Limited, a HKU spin-off company supported by TSSSU@HKU, won a silver award for its innovation in Direct Thermal-Charging Cell (DTCC). Its specialises in its patented technology of thermally chargeable battery, which is a direct thermal-charging cell (DTCC) that can make an efficient conversion from low-grade heat to electricity. It was an awardee of the HKU DreamCatcher 100K in 2018.



HKU Spin-off Company Fano Labs and Student Team ClearBot Won Jumpstarter 2020 Global Pitch Competition

Fano Labs Limited, a HKU spin-off company supported by TSSSU@HKU, was selected as one of the top five winning teams in the Jumpstarter 2020 Global Pitch Competition hosted by Alibaba Entrepreneurs Fund. More than 500 teams from all over the world participated in the competition. The top five teams were awarded up to US$5 million in investment commitments, as well as a total cash prize of US$100,000. As a deep tech start-up company, Fano Labs Limited focuses on Automatic Speech Recognition (ASR) and Natural Language Processing (NLP) and provides enterprises with AI solutions to enhance their customer services, compliance and other lines of businesses. It has been hailed as one of the best language AI companies in the Asia Pacific region.

In the meantime, HKU student team ClearBot won the championship in Jumpstarter IDEAPOP!, a pitching competition for students from universities in Hong Kong. As an artificial intelligence-driven robotic system which collected plastic waste in water automatically, ClearBot provides an innovative solution to waste disposal, removal of marine debris and plastic pollution.

2.4 COVID-19 Related Work

The COVID-19 pandemic, caused by the coronavirus SARS-CoV-2, upends lives around the world. In these trying times, scientists and researchers in HKU have put their heads together to develop vaccines, antivirals and diagnostic methods for the prevention and treatment of COVID-19. Working along with these experts, TTO has played a crucial role in providing them with valuable advice and immediate support through industry engagement, legal consultation, and patent filings in the process of technology transfer. Below are some highlights of our work in the midst of the "coronacrisis".

Exploring a Flu-based Coronavirus Vaccine

The HKU team led by Professor Honglin Chen, alongside team members Professor Zhiwei Chen and Professor Kwok-Yung Yuen, made a vaccine candidate based on a previously established flu-based DelNS1 live attenuated influenza virus (LAIV) platform. This vaccine candidate expresses a specific antigen to induce immunity targeting the critical element of the receptor binding domain (RBD) of SARS-CoVs. Such a strategy may avoid potential antibody dependent enhancement (ADE) as observed in the experimental vaccine for SARS-CoV. Furthermore, the LAIV platform has been proved to be safe and allows the vaccine production in both egg and mammalian cell systems.

Creative Responses to the Pandemic

Members from the Faculty of Business and Economics (FBE) and the Faculty of Engineering are contributing their creative ideas and expertise to the hard-fought battle against the COVID-19 pandemic. In light of the growing demand for protective gears and surgical face masks, TTO has been exploring exciting opportunities with the industry to develop the core components based on some of the novel nano-fabrication materials researched and developed at the Department of Civil Engineering. Weavatools Limited, a HKU startup company founded by graduates and professors from the Department of Computer Science and FBE, has made its flagship product, Weava - a digital research tool, available to universities and colleges worldwide free of charge to support e-learning activities of students at all levels.

COVID-19 Vaccine Development

As the COVID-19 pandemic runs rampant, rapid nucleic acid amplification tests have been developed by the HKU Li Ka Shing (LKS) Faculty of Medicine to detect the disease besides extensive research and study of the virus, its transmissibility and infection control. These tests have been used by healthcare laboratories in more than 40 countries, including Egypt, Cambodia and Nepal. The reference materials and reagents have been freely provided to overseas laboratories so that they can prepare for this pandemic and identify COVID-19 patients early. In early September 2020, HKU's State Key Laboratory for Emerging Infectious Diseases Vaccine Team was approved by China's National Medical Products Administration for human clinical trials using the vaccine candidate that it co-developed based on the established LAIV platform. In addition to the research efforts, HKU also serves an advisory role to the HKSAR government in policy formulation and provides invaluable guidance to the general public in combating the pandemic.

The Upsurge in Patent Filings

There has been a surge in COVID-19 related patent applications by pharmaceutical companies around the world. Successful applications abound. AIM Immuno Tech received three US provisional applications for its lead drug Ampligen. Gilead Sciences holds several patents and patent applications in using Remdesivir. Since February, our researchers at HKU have had six patent application filings for COVID-19 related inventions, with at least five new applications being underway. The majority of these patent applications covers areas such as vaccines, diagnosis kits and assays.

3. FOSTERING INNOVATION AND ENTREPRENEURSHIP

3.1 iDendron and DreamCatchers

iDendron – HKU's innovation and entrepreneurship hub – was established in October 2017 with the aim of nurturing entrepreneurial and innovative spirit on campus. It provides support for HKU's early-stage startups and for establishing interdisciplinary cooperation as well as incubation programmes.

iDendron has been hosting over 80 HKU students and alumni startup teams and organised more than 30 events, workshops and sharing sessions by startup founders. Over 200 active members have been working in the iDendron space on and off. Active engagement with stakeholders in the startup eco-system has been made via meetings, visits and online interactions on a daily basis through social media platforms including YouTube, LinkedIn and Facebook. Highlights in the reporting year include the following:

(a) Launched the *"Meet HKU Startup Founder" Series:* A regular and weekly online live show to showcase HKU startup teams founded by students and graduates. It is livestreamed to various platforms including Facebook, YouTube and Twitter. On average, there are more than 2,000 views for each episode.
(b) *Entrepreneurship Academy 2019:* This popular workshop on entrepreneurship was offered again in October 2019. Over 300 students, alumni, staff and friends participated in 10-week entrepreneurship courses, covering the topics of the core of entrepreneurship, focusing on integrating information and ideas from multiple perspectives in order to help participants recognise and gauge the critical factors in the commercialisation process of innovation.
(c) iDendron startup teams have been growing and scaling up such as actively recruiting staff and interns. Over 170 employment opportunities have been created by iDendron startups.
(d) HKU entrepreneurship and innovation achievements have been promoted and publicised through exhibitions at Entrepreneurs Day and Smart Biz Expo organised by the Hong Kong Trade Development Council. Over 20 HKU teams showcased their achievements.

The iDendron Incubation Programme (iIP), launched in late July 2019, is a high-impact 6-month programme designed to help early-stage startups gain momentum through deep mentor engagement, investor relation building, exposure outreaching and business support. We aim to create a community connecting potential elite founders from a wide spectrum of fields who share a common vision to create an impact for the future. A total of 12 startups graduated from the first cohort and 9 startups have been selected as the second cohort. Highlight are as follows –

(a) Engaged 40 mentors with diverse backgrounds, including startup founders, investors and other startup ecosystem players who have rich experiences in pitching, fundraising, international expansion and growth marketing. Pitching events were organised to help match the teams with mentors.
(b) First Entrepreneurship Exchange Programme: A delegate of 30 HKU students, staff and graduates had the opportunity to visit Bangkok. They hosted 12 sharing and networking sessions in 2.5 days with more than 30 speakers and mentors from Thailand.
(c) Active promotion in the media: 52 media promotions in local and international media in print and electronic versions had been launched to boost the exposure as well as reputation of HKU startups and to reach new customers and create brand recognition.
(d) Peer-to-peer experience sharing on how startups can survive during COVID-19 and maximise their brand awareness through search engine optimization(SEO) improvement

(e) Some selected milestones of incubatees:
  (i) 2 incubatees successfully raised HK$1.3M in total;
  (ii) 5 incubatees successfully expanded to overseas markets, including Taiwan, Finland, Singapore and Indonesia;
  (iii) Business collaborations among incubatees;
  (iv) Transformation and better performance during COVID-19.

iDendron has been supporting students to join various local and overseas innovation and entrepreneurship activities to help realise their ideas. Our students performed well in various technology startups and social innovation competitions. Some examples of the awards include the following:

(a) Microsoft Imagine Cup World Champion by Hollo: mental health companion web application co-founded by students from the Faculty of Science and the Faculty of Engineering.
(b) HK University Student Innovation & Entrepreneurship Competition: HKU had the best performance among other universities, with 19 winning teams and 3 of them winning first prize.
(c) Jumpstarter (organised by Alibaba Entrepreneurs Fund): Champion Team (Clear bot, an autonomous swarm robotics system to clean our oceans, co-founded by engineering students) and top 4 (Soonlution, innovative shellfish raft design, co-founded by science students) in university students track.
(d) Hong Kong Social Enterprise Challenge: 3 HKU teams awarded Champion and 1st Runner up (out of 4 teams).
(e) Cyberport University Partnership Programme: All 3 HKU teams nominated via iDendron won HK$100,000 awards.

4. COMMITMENT TO KNOWLEDGE ACCESS AND COMMUNITY ENGAGEMENT

4.1 Faculties' Core Activity

All Faculties are committed to public engagement to share knowledge and raise awareness on important issues facing society. A wide variety of activities were conducted in 2019/20, including public seminars, press briefings, conferences, publications on mass media, international competitions, and two-way KE through new media such as online social media platforms. For example, the LKS Faculty of Medicine organised a number of public KE lectures and seminars covering topics such as the functioning of body organs; prevention of metabolic diseases; latest knowledge on ophthalmology; and biologics and therapeutics for systemic lupus erythematosus.

Community engagement and collaboration continued to be a salient element in the various KE efforts of the Faculties. The Faculties had worked with partners and stakeholders in the community. While some KE activities had been put on hold due to COVID-19, many of the engagement projects had continued through different forms such as online webinars.

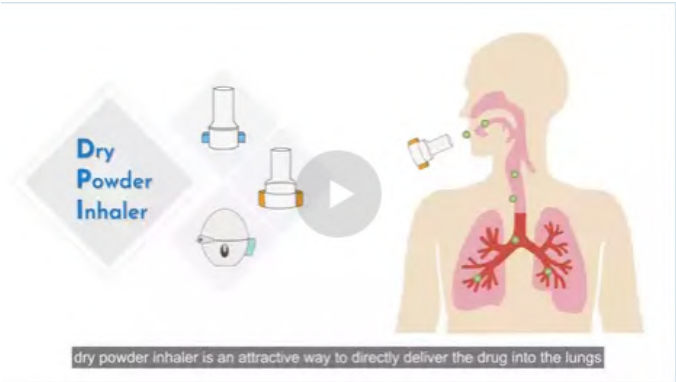
4.2 Strengthening Research Communication Skills for RPg Students

(a) HKU Three Minute Thesis (3MT) Competition

The 3MT concept was first conceived by the University of Queensland. Many leading universities around the world have subsequently espoused this practice to promote KE, especially among young people. Since 2011, KEO and Graduate School of HKU have jointly organised the annual 3MT Competition, challenging final year research postgraduate students to explain their research within 3 minutes to a general audience.

HKU 3MT Competition was held in June 2020. There were two rounds of competition. The top 10 students selected in the first round competed in the final one. The winner of the HKU 3MT Competition will represent HKU in the Asia-Pacific 3MT Competition in October 2020. The 3MT Competition has been well-received in the past. It is one of the key measures to entrench the culture of KE in HKU.

(b) *HKU Visualise Your Thesis (VYT) Competition*



Visualise Your Thesis is an initiative introduced by The University of Melbourne that challenges Research Postgraduate students (RPg) to present their research in a 60-second, eye-catching digital display. HKU VYT

2020 was held from May to August 2020. This Competition provided another valuable opportunity for the HKU RPg students to develop research communication skills for a general audience. It also served as a platform for the RPg students to enhance their digital literacy, which is another useful skill set for researchers nowadays. The Champion will represent HKU in the online International VYT Competition 2020 organised by The University of Melbourne, currently scheduled for the last quarter of 2020.

5. QUANTITATIVE INDICATORS AND FINANCIAL REPORT

HKU uses a broad definition of KE, hence our performance indicators include not only those required by UGC, but also other indicators that are pertinent to the University's KE efforts. Two tables on the UGC and HKU performance indicators are at Annex II. The internal distribution of KT funding allocation is summarised at Annex III.

6. LOOKING AHEAD

The outbreak of COVID-19 pandemic was as much a public health challenge as an opportunity for different sectors of the community to work shoulder and shoulder to deal with issues of common concern. The importance of KE and promotion of innovations can hardly be overstated in these challenging times. HKU's research outcomes have been brought to the frontline to help the government, the broader research communities across the world as well as the general public better understand the pandemic and measures to arrest the otherwise unbridled spread of the pandemic in Hong Kong and other places.

Recognising innovations through KE is important to spur and commend sharing of innovations with the broader community. The importance of innovations is underscored by Hong Kong's drive for transformation into a smart and sustainable city. Against this backdrop, two new KE awards, namely the HKU Innovator Award and Young Innovator Award, will be organised from 2020/21 onwards to recognise outstanding innovations that have a clear potential of great impact in the future. The new awards will not only encourage the sharing of innovations with the community, but also recognise projects that capitalise on the research prowess of HKU to help foster the development of new innovative industries and use of nascent technologies and practices in HK and other places.

On KE capacity building, we have commenced the review of the 74 HKU Research Assessment Exercies (RAE) 2020 impact cases that will be available to the general public when the RAE 2020 results are released. These cases are being compared with selected Research Excellence Framework 2014 impact cases from the relevant

disciplines in terms of content, submitters, engagement type and impact type. We will also review the HKU RAE 2020 impact cases and make the comparison with the other HK impact cases in terms of content, submitters, engagement type, impact type and scores. The results will be used to further refine HKU's KE strategies and reinforce various measures to promote KE.

The University of Hong Kong
October 31, 2020

University: The University of Hong Kong (HKU)

Faculty: Li Ka Shing Faculty of Medicine

Title of case study: Knowledge Exchange on HIV/AIDS to promote HIV prevention and care

(1) Summary of the impact (indicative maximum 100 words)

Our team has done tremendous amount of KE work in promoting HIV prevention and care in Hong Kong and in China during the past decade, and has achieved significant impacts in the following areas: A) Governmental policies and guidelines, B) Public awareness, C) Community education, and D) Biomedical industry development. Here, we present our discovery of PD1-based vaccine for HIV-1 immunotherapy, which has led to multiple high impact publications, a HKU patent, improved HIV awareness, better community education, a biomedical startup company Immuno Cure in Hong Kong, and the subsequent success of our 2018/2019 TRS grant for the vaccine clinical development.

(2) Underpinning research (indicative maximum 500 words)

With previous supports from RGC General Research Fund/Collaborative Research Fund and Health and Medical Research Fund (HMRF), we have made some important findings, leading to HKU-patented technology on programmed death-1 (PD1)-based vaccine. HIV-1-specific $CD8^+$ T lymphocytes are essential for suppressing viral replication, yet few vaccine candidates could elicit such cellular immunity. We hypothesize that PD1-based vaccine immunotherapy will provide a prolonged viremia control by potentiating host immunity. This hypothesis is mainly based on the following discoveries.

In our first study, we reported the development of a novel antigen-targeting DNA vaccine strategy that exploits the binding of PD1 to its ligands expressed on dendritic cells (DCs) by fusing soluble PD1 with HIV-1 GAG p24 antigen (*Journal of Clinical Investigation* 2013, *Molecular Therapy-Cell Press* 2013). As compared with non-DC-targeting vaccines, intramuscular immunization via electroporation (EP) of the PD1-based vaccine in mice elicited consistently high frequencies of GAG-specific, broadly reactive, polyfunctional, long-lived, and cytotoxic $CD8^+$ T cells and robust anti-GAG antibody titers. Vaccination conferred remarkable protection against mucosal challenge with a vaccinia-GAG virus. We found that PD1-based vaccination potentiated $CD8^+$ T cell responses by enhancing antigen binding and uptake in DCs and activation in the draining lymph node. It also increased IL-12-producing DCs and engaged antigen cross-presentation when compared with the anti-DEC205 antibody-mediated DC targeting approach. The high frequency of durable and protective GAG-specific $CD8^+$ T cell immunity induced by PD1-based vaccination suggests that this vaccine strategy could potentially be used against HIV-1 and other pathogens. In the meantime, PD1-based vaccines also displayed potential for cancer immunotherapy (*Cancer Research* 2014).

Considering that HIV-1 functional cure requires sustained viremia control without antiretroviral therapy, we further investigated PD1-based vaccine in non-human primate models. We designed a recombinant DNA vaccine that targets the simian immunodeficiency virus (SIV) capsid antigen to DC via a fused rhesus soluble PD1 domain. Homologous PD1-based DNA vaccination suppressed setpoint viremia to undetectable levels in all rhesus macaques tested following high-dose intravenous challenge with pathogenic simian-human immunodeficiency virus $SHIV_{SF162P3}$. The vaccine induced high frequencies of polyfunctional effector-memory $CD8^+$ T cells, which were re-called potently upon the viral challenge. All vaccinated macaques under long-term observation showed sustained viremia control for over 2 years. Depleting $CD8^+$ T cells resulted in transient viremia, highlighting the involvement of vaccine-induced $CD8^+$ T cells in $SHIV_{SF162P3}$ control. In summary, the PD1-based vaccination shows potential as a straightforward approach

towards a functional SIV/HIV cure.

Based on these critical findings, this vaccination method has been patented by HKU TTO for technology transfer, which resulted in the establishment of a biomedical company called **Immuno Cure Ltd Hong Kong** through the TSSSU@HKU award. With promising progresses made, we have successfully obtained the UICP grant (UIM/314, HK$21m) in 2017 for GMP-manufacturing the PD1-based vaccine and later the 2018/2019 RGC TRS grant (T11-706/18-N, HK$47m) for mechanism and translational studies on combined PD1-based vaccine and tandem bispecific neutralizing antibody (*Journal of Clinical Investigation* 2018) in monkey models and human subjects. Therefore, our discovery has been moved from laboratory towards clinical trials, which is remarkable.

(3) References to the research (indicative maximum of six references)

Zhou J, Cheung AKL, Tan Z, Wang H, Du Y, Kang Y, Lu X, Liu L, Yuen KY and **Chen Z***. PD1-based DNA vaccine amplifies HIV-1 GAG-specific $CD8^+$ T cells in mice. ***Journal of Clinical Investigation.*** 2013 Jun;123(6):2629-42. doi: 10.1172/JCI64704. Epub 2013 May 1.

Zhou J, Cheung AKL, Liu H, Tan Z, Tang X, Kang Y, Du Y, Wang H, Liu L, and **Chen Z***. Potentiating functional antigen-specific CD8+ T cell immunity by a novel PD1 isoform-based fusion DNA vaccine. ***Molecular Therapy* (*Cell Press*).** 2013 Jul;21(7):1445-55.

Tan Z, Zhou J, Cheung AK, Yu Z, Cheung KW, Liang J, Wang H, Lee BK, Man K, Liu L, Yuen KY, **Chen Z***. Vaccine-elicited CD8+ T cells cure mesothelioma by overcoming tumor-induced immunosuppressive environment. ***Cancer Research***. 2014 Nov 1;74(21):6010-21.

Cheng L, Tang X, Liu L, Peng J, Nishiura K, Cheung AK, Guo J, Wu X, Tang HY, An M, Zhou J, Cheung KW, Wang H, Guan X, Wu Z, **Chen Z***. Monoclonal antibodies specific to human Δ42PD1: A novel immunoregulator potentially involved in HIV-1 and tumor pathogenesis. ***MAbs***. 2015 May 4;7(3):620-9.

Cheung AKL, Kwok HY, Huang Y, Chen M, Mo Y, Wu X, Lam KS, Kong HK, Lau TCK, Zhou J, Li J, Cheng L, Kiat Lee B, Peng Q, Lu X, An M, Wang H, Shang H, Zhou B, Wu H, Xu A, Yuen KY, **Chen Z***. Gut-homing Δ42PD1+Vδ2 T cells promote innate mucosal damage via TLR4 during acute HIV type 1 infection. ***Nature Microbiology***. 2017 Oct;2(10):1389-1402.

Wu X, Guo J, Niu M, An M, Liu L, Wang H, Jin X, Zhang Q, Lam KS, Wu T, Wang H, Wang Q, Du Y, Li J, Cheng L, Tang HY, Shang H, Zhang L, Zhou P, **Chen Z***. Tandem bispecific neutralizing antibody eliminates HIV-1 infection in humanized mice. ***Journal of Clinical Investigation***. 2018 Jun 1;128(6):2239-2251. doi: 10.1172/JCI96764. Epub 2018 Apr 23. pii: 96764. doi: 10.1172/JCI96764.

*corresponding author

(4) Details of the impact (indicative maximum 750 words)

HIV-1 is the causative agent of AIDS. To date, HIV-1 continues to spread, leading to 36.9 million people living with the virus and about 40 million deaths worldwide. In Hong Kong, despite aggressive prevention programs and timely introduction of antiretroviral therapy (ART), the number of cumulative infections has increased from 776 in 1996 to 9715 in 2018. Financially, ART expense alone has increased to estimated HK$550 millions in 2017-18. Since the life-long ART is unlikely sustainable and does not cure HIV/AIDS, our research objective is to discover an effective immunotherapy of potentiating host immunity to achieve a functional cure, a state of suppressed viremia below detection limit for a prolonged period in HIV-infected patients without

receiving ART. This would significantly reduce the adverse effects of the ART in patients and the financial burdens to the governments and patients.

For this purpose, we proposed to prove the concept of PD1-based vaccine and successfully won a RGC GRF grant. After we found that PD1-based vaccine preferentially induces antigen-specific $CD8^+$ T cells, this discovery quickly generated KE impacts in several areas. First, we filed the initial patent application in 2010, followed by receiving the complete patent (US 9,029,315 B2) in 2015 via HKU TTO. Second, our results were officially published in *Journal of Clinical Investigation* in 2013, which led to the Award for Outstanding Research Postgraduate Student by HKU Graduate School to give due recognition to the research postgraduate student who has submitted a thesis of exceptional quality and has demonstrated outstanding performance in other academic aspects. Third, HKU press release on our findings caught extensive press coverage, which promoted the awareness of HIV/AIDS prevention and care in Hong Kong and in Mainland China. Fourth, the Hong Kong AIDS Foundation then invited Prof. Chen to give a lecture on PD1-based vaccine and its implication to HIV prevention in a local symposium. Several hundreds of people attended the event with the theme entitled "We stay together forever", which enhances KE in local communities. Fifth, due to the discovery of PD1-based vaccine, Prof. Chen was invited to give lectures in several world-renown institutions including US National Institutes of Health, The Institut Pasteur in Paris, The Ragon Institute of Massachusetts General Hospital (MGH)/Massachusetts Institute of Technology (MIT)/Harvard University, Aaron Diamond AIDS Research Center of the Rockefeller University, and The Peter Doherty Institute for Infection and Immunity. Sixth, as an invited speaker, Prof. Chen gave an oral presentation on PD1 vaccine-based immunotherapy in Madrid at HIVR4P, the world's first and only international scientific meeting dedicated exclusively to biomedical HIV prevention research. Seventh, with the help by HKU TTO, we successfully won the TSSSU@HKU award in 2015 and started a local biomedical company, namely Immuno Cure Ltd Hong Kong, allowing human PD1-based vaccine for research and development. Eighth, based on our satisfactory performance of the TSSSU@HKU, we have further been awarded a UICP grant in 2017, entitled "A Novel PD1-based Vaccine for HIV/AIDS Immunotherapy". Lastly, by securing the GMP production of PD1-based Vaccine for HIV/AIDS Immunotherapy through the UICP grant (UIM/314), we were able to construct a team of researchers winning the only HKU RGC TRS award in 2018/2019 (TRS:T11-706/18-N), entitled "Potentiating Host Immunity for HIV-1 Functional Cure". Notably, we also contributed significantly to the governmental "Recommended HIV/AIDS Strategies for Hong Kong 2017-2012", "HIV manual", "International AIDS Society global scientific strategy: towards an HIV cure 2016" (Nat. Med. 2016), and the 2019 "China New Development Award"-wining book "HIV Vaccines and Cure" (Springer Nature).

In summary, we were the first group in the world reporting PD1-based vaccine that promotes the induction of HIV-specific $CD8^+$ T cells capable of eliminating virus-infected cells in animal models. Based on this discovery, our KE activities involved a broad range of impacts as mentioned above, which not only achieved the technological transfer of our patent to develop a biomedical company and public awareness of HIV prevention and care in Hong Kong, but also signified the strategical importance of HKU in the fight against the global HIV/AIDS pandemic.

(5) Sources to corroborate the impact (indicative maximum of 10 references)

1. Award for Outstanding Research Postgraduate Student (HKU) publication:
   Zhou J, Cheung AKL, Tan Z, Wang H, Kang Y, Du Y, Lu X, Liu L, Yuen KY and Chen Z*. PD1-based DNA vaccine amplifies HIV-1 GAG-specific CD8+ T cells in mice. *Journal of Clinical Investigation*. 2013 Jun 3;123(6):2629-42.
2. HKU patent: No.: US 9,029,315 B2, Date: May 12, 2015; Patent: Soluble PD-1 Variants, Fusion Constructs, and Uses Thereof.
3. Hong Kong news coverage on our discovery after the HKU press release:

October 25, 2013

人民日報: "香港大學陳志偉博士完成愛滋病黏膜疫苗前期臨床研究，取得國際專利 - 二十年如一日抗愛滋"

September, 2013

Networking Voice by Red Ribbon Center: 愛滋病疫苗的研究進展

May 20, 2013

Wen Wei Po: '公共衛生：港產愛滋剋星'

May 16, 2013

Metropolis Daily: '港大成功研愛滋苗'

Hong Kong Economic Times: '港大研基因疫苗 冀可治愛滋'

Sky Post: '愛滋基因疫苗 清除8成病毒'

Yahoo Hong Kong: '港大研抗愛滋DNA疫苗'

Discuss.com.hk:

'港大醫學院發明全球第一支愛滋病疫苗'

Sina Hong Kong: '港大研抗愛滋DNA疫苗'

May 16, 2013

南华早报: 港大发明艾滋病新疫苗

SCMP: 'HKU scientists find potential new HIV drug'

SCMP: 'Insight & Opinion - HIV treatment - Who said it?'

Apple Daily News: '港大研發DNA疫苗 刺激細胞滅愛滋'

The Standard: "Hopeful' step taken to HIV vaccine'

Oriental Daily News: '新疫苗殺死愛滋病毒'

May 15, 2013

'HKU discovers a novel DNA vaccine which can induce a high frequency of CD8+T cells to combat Aids - A new strategy for designing AIDS vaccine'

'HKU discovers a novel DNA vaccine which can induce a high frequency of CD8+T cells to combat Aids - A new strategy for designing AIDS vaccine'

World News: "Hopeful' step taken to HIV vaccine'

4. Invited lecture by Hong Kong AIDS Foundation for hundreds of local community people on our PD1-based vaccine in 2013.

5. Invited lectures at world-leading research institutions and universities to exchange our findings on PD1-based vaccine including (1) US National Institute of Health for The Neuroscience Consortium Cutting Edge Symposium, (2) The Ragon Institute of MGH, MIT and Harvard, (3) The Aaron Diamond AIDS Research Center of Rockefeller University, and (4) Institut Pasteur in Paris.
6. Invited speakers at international meetings including HIVR4P, the world's first and only international scientific meeting dedicated exclusively to biomedical HIV prevention research in Madrid, and The International Global Virus Network (GVN) Meeting hosted by The Peter Doherty Institute for Infection and Immunity in Australia.
7. TSSSU@HKU award, TSSSU/HKU/15/02/1; Date: May 2015 – April 2016, "PD1-BASED DNA VACCINE FOR AIDS"
8. UICP grant award, UICP: UIM/314 "A Novel PD1-based Vaccine for HIV/AIDS Immunotherapy"
9. RGC TRS award, TRS: T11-706/18-N "Potentiating Host Immunity for HIV-1 Functional Cure" in 2018/2019.
10. Invited Speakers in 2019, (1) Cent Gardes Conference: HIV Vaccine, "This biennial symposium gathers international speakers of the highest level together"; (2) The 6th National Academic Conference on HIV/AIDS, "是我国艾滋病防治领域水平最高、最为盛大的学术交流活动"

University: The University of Hong Kong (HKU)

Faculty: Faculty of Engineering

Title of case study: Modular Integrated Construction (MiC) for Buildings of Higher Quality, Productivity and Sustainability in Hong Kong

1. Summary of the impact (indicative maximum 100 words)

This case study develops a new approach and disruptively innovative solutions for policy for, research on, and practice of delivering high-rise buildings in Hong Kong of higher quality, productivity and sustainability. The case study has contributed predominantly or significantly to MiC government policy and strategy, academic and applied research, government and industry training and learning, public engagement, MiC pilot projects implementation, and knowledge dissemination. Examples of impact include: co-created basis for a new policy in the Policy Address and a MiC strategy paper; facilitated industry transformation; sizeable grants from RGC, government and industry; provided expert advice, support and training.

2. Underpinning research (indicative maximum 500 words)

The underpinning research projects include:

- RGC Research Impact Fund (RIF) "Modular Integrated Construction MiC 2.0+ for Quality and Efficient Tall Residential Buildings through Advanced Structural Engineering, Innovative Building Materials and Smart Project Delivery", **HK$14.3million**, 2019-24, PC/PI: Dr Pan
- CIC Research Fund "Modular Integrated Construction (MiC) for High-rise Building in Hong Kong: Supply Chain Identification, Analyses and Establishment", **HK$4.95million**, 2018-19, PI: Dr Pan
- Research Project "Feasibilities of Adopting Modular Integrated Construction (MiC) for High-rise Buildings in Hong Kong", funded by Development Bureau, HKSAR Government, **HK$2.77million**, 2017-19, PI: Dr Pan
- Research Project "Study on Performance of Modular Integrated Construction (MiC) Pilot Project", funded by Development Bureau, HKSAR Government, HK$1.85million, 2018-20, PI: Dr Pan
- Research Project "Viability Study of Modular Integrated Construction (MiC) Application in Public Housing Construction", Funded by Hong Kong Housing Authority, HK$598,000, 2018-19, PI: Dr Pan

Significance of the key insights or findings from the research:

- It is technically feasible for up-to-40-storey steel-framed MiC buildings to resist the wind loads specified in the HK code.
- It is viable to construct 40-storey precast concrete MiC public residential buildings in HK.
- The benefits from MiC should include: up to 50% construction time saving, up to 80% construction waste reduction, up to 100% accident reduction, up to 50% site labour reduction, up to 20% construction cost saving, etc. Nevertheless, these benefits are still to be witnessed in the MiC pilot projects.
- MiC should spearhead the construction innovation and technology in HK, and will lead to improved culture of the HK industry and society.

The underpinning research includes:

- Co-created the basis for a new policy initiative (MiC) in the Policy Address
- The new concept of MiC was developed through collaboration between HKU (led by Dr Pan) and the Development Bureau of the HKSAR Government.

- MiC is defined in an explicit manner in the first ever journal publication on MiC in the world authored by Dr Pan and the then Permanent Secretary for Development (Works) of the HKSAR Government (Pan and Hon, 2018)
- Produced a Strategy Paper on MiC entitled "Modularisation for Modernisation: A Strategy Paper Rethinking Hong Kong Construction" (to be published), commissioned by Development Bureau, HKSAR Government.
- Dr Pan and his team have published all of the three academic journal articles (ISI listed) on MiC, which have ever appeared as of March 2019 in the world.
- Developed structural solution for up to 40-storey MiC building using steel-framed modules (1st in HK & world-leading to our knowledge)
- Studied viability of 40-storey MiC public residential building using precast concrete modules (1st in HK & world-leading to our knowledge)
- Developed performance measurement system for MiC project (1st in HK & world-leading to our knowledge)
- Studied MiC supply chain with developed smart-tech digital platform and mobile App (1st in HK & world-leading to our knowledge)
- Proposed approach of MiC 2.0+ for quality and efficient tall residential buildings through advanced structural engineering, innovative building materials and smart project delivery (1st in the world to our knowledge).

3. References to the research (indicative maximum of six references)

Largest RGC Research Impact Fund (RIF):

1. RGC Research Impact Fund "Modular Integrated Construction 2.0+ for Quality and Efficient Tall Residential Buildings through Advanced Structural Engineering, Innovative Building Materials and Smart Project Delivery", **HK$14.3million** (RGC HK$9.9m; matching HK$4.2m), PC/PI: Dr Pan; with Co-PIs from three universities covering disciplines of construction engineering, management, structural engineering, materials science, IT in construction, computer simulation, as well as a wide range of government departments, industry organisations, and international stakeholders.

Largest Construction Industry Council (CIC) Research Fund:

2. CIC Research Fund "Modular Integrated Construction for High-rise Building in Hong Kong: Supply Chain Identification, Analyses and Establishment", **HK$4.95million**, PI: Dr Pan; with Co-Is covering construction management, structural engineering, and manufacturing and system engineering;

Sizeable Research Fund from HKSAR Government:

3. Research Project "Feasibilities of Adopting Modular Integrated Construction (MiC) for High-rise Buildings in Hong Kong", funded by Development Bureau, HKSAR Government, **HK$2.77million** (PI: Dr Pan; and Co-Is from disciplines of structural engineering, seismic engineering);

1st ever academic journal publication in the world on MiC:

4. Pan, W.* and Hon, C.K. (2018) Modular Integrated Construction for High-rise Buildings. Journal of Proceedings of The Institute of Civil Engineers – Municipal Engineer, https://doi.org/10.1680/jmuen.18.00028.

1st ever academic journal publication in the world on MiC structural analysis:

5. Shan, S., Looi, D.T.W., Cai, Y., Ma, P., Chen, M., Su, K.L., Young, B. and Pan, W.* (2019) Engineering modular integrated construction systems for high-rise building: A Hong Kong case study. Journal of Proceedings of the Institution of Civil Engineers: Civil

Engineering. https://doi.org/10.1680/jcien.18.00052.

Co-created basis for the MiC policy initiative in the Policy Address and the MiC Strategy Paper:

6. Pan, W., Yang, Y., Zhang, Z., Luo, B. and Chan, S. (forthcoming) Modularisation for Modernisation: A Strategy Paper Rethinking Hong Kong Construction. Commissioned by Development Bureau, HKSAR Government.

4. Details of the impact (indicative maximum 750 words)

Co-created the basis for a new policy initiative (MiC) in the Policy Address:

1. The new concept of Modular Integrated Construction (MiC) was developed through collaboration between HKU CICID (led by Dr Pan) and the Development Bureau of the HKSAR Government. The HKU team contributed the knowledge underpinning the development of this new concept and policy initiative in the Policy Address 2017 and 2018.
2. MiC is defined in an explicit manner in the first ever journal publication on MiC in the world authored by Dr Pan, and Mr CK Hon (the then Permanent Secretary for Development (Works) of the HKSAR Government), as
   "A game-changing disruptively-innovative approach to transforming fragmented site-based construction of buildings and facilities into integrated value-driven production and assembly of prefinished modules with the opportunity to realise enhanced quality, productivity, safety and sustainability" (Pan and Hon, 2018, ICE Journal Municipal Engineer)

Produced a MiC Strategy Paper via a study for the HKSAR Government:

3. Dr Pan and his team has produced a strategy paper that elaborates on the MiC policy initiative and provides strategies for MiC development in Hong Kong (to be published soon):
   - Pan, W., Yang, Y., Zhang, Z., Luo, B. and Chan, S. (forthcoming) Modularisation for Modernisation: A Strategy Paper Rethinking Hong Kong Construction. Commissioned by Development Bureau, HKSAR Government.

World-leading research into the new area of MiC:

4. Dr Pan and his team have published all of the three academic journal articles (ISI listed) on MiC, which ever appear so far in the world.

Largest RGC RIF (total HK$14.3m) & several sizeable grants from Government and industry on MiC:

5. These research projects provide excellent KE among academia, government, industry and community, e.g. the RIF involves Co-PIs from three universities covering disciplines of construction engineering, management, structural engineering, materials science, IT in construction, computer simulation, as well as a wide range of government departments, industry organisations, and international stakeholders.

Provided expert advice on MiC to HKSAR Government and industry:

6. Our expert advice provided on MiC to the government departments and industry bodies, and the MiC pilot projects (listed above) leads to many benefits:
   - Government policy on MiC informed and backed up by our academic research, with MiC being promoted for more and more projects in various building sectors including hostel, public housing, staff quarter;
   - The benefits to be realised in building projects should include:
     - up to 50% construction time saving,
     - up to 80% construction waste reduction,
     - up to 100% accident reduction,

- up to 50% site labour reduction,
- up to 20% construction cost saving, etc.

Although these benefits are still to be witnessed in the few MiC pilot projects, Dr Pan and his team have contributed tremendously to the improved knowledge and confidence of the HK government and industry about the use of MiC.

Provided academic support for the MiC International Conference co-organised by Development Bureau and Construction Industry Council:

7. Dr Pan provided all academic support, including designing the conference theme, structure and contents, inviting all overseas speakers, and liaising for all MiC technical issues. About 350 participants benefited from the KE.

Provided MiC training for Government and industry:

8. Dr Pan delivered an Invited Training session on MiC and productivity for HKSAR Government officials as part of the HKSAR Government's 'Project Capability Building Programme', HK, 11 Apr 2018. About 200 government engineers and officials benefited from the KE.
9. Dr Pan organised one-day training on MiC for HKSAR Government officials and industry practitioners, HK, 25 Apr 2018. Over 80 government officials and industry practitioners benefited from the KE.

Coordinated / organised many overseas MiC study visits and delegations for HKSAR Government, public sector clients and industry:

10. Dr Pan and his team have organised many (most) MiC related overseas study visits and delegations in recent years. Numerous members from Government, industry and academia benefited from the MiC KE. This has made invaluable contribution to the promotion and uptake of MiC in Hong Kong.

Invited Keynotes/Speeches at International Conferences:

11. Dr Pan delivered a range of invited keynotes/speeches on MiC for knowledge sharing, dissemination and promotion internationally (listed above). Dr Pan has firmed up the HK-leading research & development on MiC in the world.

Invited Plenary/Speeches at Conferences in Hong Kong:

12. Dr Pan delivered a range of invited keynotes/speeches on MiC for knowledge sharing, dissemination and promotion within HK, which contributes to the momentum of both academic research and industry uptake of MiC.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Sources to corroborate the impact	Relevant impact item Under Section 4
1. Development Bureau, HKSAR Government (the Project Cost Management Office – PCMO, as the MiC policy unit of the Bureau);	Items 1, 2, 3
2. Pan, W.* and Hon, C.K. (2018) Modular Integrated Construction for High-rise Buildings. Journal of Proceedings of The Institute of Civil Engineers – Municipal Engineer, https://doi.org/10.1680/jmuen.18.00028. 3. Pan, W.*, Su, R., Cai, Y. and Young, B. (2018) Engineering modular systems for high-rise buildings: an update. Journal of	Item 4

Proceedings of the Institution of Civil Engineers: Civil Engineering, 171(4), 148. 4. Shan, S., Looi, D.T.W., Cai, Y., Ma, P., Chen, M., Su, K.L., Young, B. and Pan, W.* (2019) Engineering modular integrated construction systems for high-rise building: A Hong Kong case study. Journal of Proceedings of the Institution of Civil Engineers: Civil Engineering. https://doi.org/10.1680/jcien.18.00052.	
5. RGC RIF, Development Bureau (PCMO) and CIC (Research Department) https://www.info.gov.hk/gia/general/201901/08/P2019010800637.htm	Item 5
6. Development Bureau (PCMO), HKSAR Government http://www.cpao.hku.hk/media/170928_TVB_News.iphone4.mp4	Item 6
7. Development Bureau (PCMO), HKSAR Government	Item 7
8. Development Bureau (PCMO), HKSAR Government http://www.civil.hku.hk/cicid/3_events/20180425/detail-20180425.pdf	Items 8, 9, 10
9. Various web links, e.g.: https://cife.stanford.edu/ICForum2019; https://www.wlv.ac.uk/about-us/our-schools-and-institutes/faculty-of-science-and-engineering/school-of-architecture-and-built-environment/iccf/keynote-speakers/ ;	Items 11, 12

University: The University of Hong Kong (HKU)

Faculty: The Faculty of Social Sciences

Title of case study:
Influencing drug policies and well-being of drug users in Hong Kong and East & Southeast Asia

1. Summary of the impact (indicative maximum 100 words)

Globally the impact of illicit drug use on individuals and communities has been a key priority among public health officials, law-enforcement authorities and government policymakers. Professor Karen Joe-Laidler's work has produced empirically grounded analyses that challenge assumptions embedded in drug policy, promote understanding of the changing environment of drug use and the needs of drug users, and advocate policies to reduce drug related harms. This research has informed and shaped sentencing guidelines for drug trafficking in Hong Kong; Southeast Asian professionals' engagement with policy, advocacy, and programs resulting from harm reduction training; and local drug treatment organizations' programs and services.

2. Underpinning research (indicative maximum 500 words)

Over the past two decades, the global drug market has witnessed significant shifts in drug use prevalence and preferences. Professor Joe-Laidler joined HKU in 1995; her research focuses on how these changes have played out in the Hong Kong context, and the consequences for users and the community. Her work is distinguished by its' use of ethnographic fieldwork, qualitative interviews with over 500 users, and, 25 interviews and 26 focus groups with frontline workers, as well as one school and three user population surveys.

Key Insights:

1. The shift from opiates to psychotropic drug use in Hong Kong

The research documents and analyses the nature and changes of Hong Kong's illicit drug market since it began to shift in the mid-1990s. Joe-Laidler was the lead on four projects from (2000-2006) that remain the most comprehensive analysis of Hong Kong's drug market, analysing its dynamics – supply, demand, market clearing strategies, legal responses and associated consequences, and state intervention [3.1]. These studies reveal how psychotropic drug use emerged in the drug market, especially in the context of a burgeoning night-time economy, and experienced shifts with stepped-up enforcement, and emergent underground and cross border leisure scenes. The research documents the changing rationales, contexts, and health and social problems associated with the use and decline of ecstasy and the continued popularity of ketamine, methamphetamine, cocaine, and poly-drug use among young adults who believe these drugs are not addictive nor harmful, compared with heroin. Based on a GRF study (2008-2010), generational differences have been found between local aging heroin users (in decline) and the small but increasing number of ethnic minority young adults, who marginalized and with limited local networks, rely on open street sales of heroin.

2. Changing patterns of drug supply and trafficking in Southeast Asia and beyond

Based on a GRF study (2012-2014), drug supply and trafficking patterns are closely related to the changing Hong Kong drug use scene. Frequent government raids to party/entertainment businesses resulted in a more flexible and discrete market with drug transactions becoming less visible and mobile [3.2]. As use moves to private settings, so too have transactions. In collaboration with Professor Coomber (University of Liverpool) and partners in eight other countries (HKU contribution 15%), our ten country comparison reveals that, social supply (sharing, gifting, fronting drugs with peers) occurs in local drug scenes, and while considered a

mitigating factor in sentencing drug trafficking cases in the UK and other countries, has been legally interpreted as equivalent to an aggravating factor in Hong Kong [3.5].

3. Drug treatment services must respond to changing needs of drug users in Hong Kong. Seven studies, conducted from 2003-2017, document the needs, problems and socio-economic costs associated with drug treatment. While services have been largely tailored to address the needs of heroin users, Joe-Laidler demonstrates that the problems experienced by psychotropic drug users require different strategies that are gender, ethnically, and spiritually appropriate [3.2-3.4]. One study was the first, in Hong Kong, to pilot a natural recovery approach based on Buddhist principles with a positive reception by those in residential treatment. Gaps in existing drug and health policies have also resulted in difficulties for a hidden population of users - "chem-sex" goers (men who have sex with men (MSM) who use drugs in party settings) - to seek services that can jointly address their drug use and sex problems [3.6]. This group have contributed to the rise of HIV infections among MSM.

3. References to the research (indicative maximum of six references)

[3.1] Joe-Laidler, K. A., Hodson, D., & Traver, H. (2000). The Hong Kong Drug Market. A Report for UNICRI on the UNDCP Global Study on Illicit Drug Markets. Online: https://www.crime.hku.hk/papers/hkdrugmarket.doc. Peer reviewed and one of two country reports selected from 20 countries, showcased by UNDCP (previously available on their Southeast Asia website).

[3.2] Joe-Laidler, K. (2005) The Rise of Club Drugs in a Heroin Society. *Substance Use and Misuse: An International Journal*. 40(9-10): 1257-1278.

[3.3] Joe-Laidler, K. and Hunt, G. (2008) Sit Down to Float: The Cultural Meaning of Ketamine Use in Hong Kong. Addiction, Research and Theory. 16(3): 259-271.

[3.4] Joe-Laidler K.A., Hunt G. and Moloney M. (2014) Tuned Out or Tuned In: Spirituality and Youth Drug Use in Global Times, *Past and Present*, 222(9), 61-80

[3.5] Coomber, R., Moyle, L., Belackova, V., Decorte, T., Hakkarainen, P., Hathaway, A., Joe-Laidler, K., Lenton, S., Murphy, S., Scott, J. and Stefunkova, M., (2018) The burgeoning recognition and accommodation of the social supply of drugs in international criminal justice systems: An eleven-nation comparative overview. *International Journal of Drug Policy,* 58: 93-103.

[3.6] Kong, T. and Joe-Laidler, K. (2019) The paradox for chem-fun and gay men: A neoliberal analysis of drugs and HIV/AIDS policies in Hong Kong. *Journal of Psychoactive Drugs*. Published online 31/1/2019.

Grants

This research is based on 13 peer reviewed competitive grants and contracts, conducted between 2000-2017 (with Joe-Laidler as PI on 8 of them), totalling HKD 6.2 million, and included funding from the General Research Fund (2 grants), the United Nations Interregional Crime and Justice Institute (1 grant - part of a global market analysis), the Hong Kong government (i.e., 3 Narcotics Division grants, 1 Correctional Services Department grant), and NGO consultancies (5). Among the five with Joe-Laidler as CoPI, four were done with colleagues at HKU. Joe-Laidler's contribution to these studies was her expertise on illicit drugs (HKU colleagues' expertise – sexuality and statistical methods). One comparative project – San Francisco, Hong Kong and Rotterdam - was funded by the US National Institute of Drug Abuse (NIDA) study, in collaboration with Professor G. Hunt (Aarhus University & Institute for Scientific Analysis, California) with the Hong Kong site overseen by Joe-Laidler.

4. Details of the impact (indicative maximum 750 words)

The accumulated analysis on drug trends in Hong Kong and internationally have led to three major areas of impact. These have influenced the drug using community, criminal justice system, and making of drug policies in Hong Kong and the Southeast Asia region.

1. Influenced sentencing guidelines for drug trafficking
The accumulated research provides a longitudinal knowledge base of the changes in the drug market – its diversification, differential demand of particular drugs, and supply (fluctuations, accessibility, and distribution methods). Based on the depth and breadth of knowledge from this research, Joe-Laidler's expertise was recognized by the Court of First Instance with the prosecuting counsel seeking expert evidence in the case of *HKSAR* v *Hii Siew-Cheng* [5.1]. Drawing from the extensive information gathered from users' experiences and problems, the original expert witness testimony in 2005, considered, in the local and international context: the extent and nature of use, the harms and dangers associated with ketamine, and legal considerations of ketamine and ecstasy. The court's primary query: should the existing rationale and sentencing principles for ecstasy continue to be used for ketamine given recent scientific discoveries about the two drugs and changes in use patterns. As sentencing guidelines had not been laid down specifically for ketamine, the presiding High Court Judge did not depart from existing practices, noting however, that the Court of Appeal might reconsider the decision. The prosecution case report, in reviewing its' evidence, found that Joe-Laidler's "findings were quite heavily relied upon by the Defence experts" [5.1]. In 2007, the Secretary for Justice appealed the decision, calling for a review and separation of the sentencing guidelines for ecstasy and ketamine trafficking. The Secretary for Justice requested Joe-Laidler to provide an update. In its review of her and others' updated expert evidence, the Court of Appeal established the precedent for separate guidelines for the two drugs, that the sentences be the same, but higher than those outlined by prior precedent [5.2] A review of the case, its implications and the specific guidelines were set out in the Hong Kong Law Reports and Digest in 2009 [5.3]. The Hong Kong Judiciary identified this case as one of the most notable legal cases from 2008-2009 (https://www.doj.gov.hk/publications/doj2010/en/highlight.html).

The rationale and guidelines have been cited in nearly 700 cases on drug trafficking [5.5]. In 2017, the court requested further updates from Joe-Laidler in an appeal to the high court, in the cases of *HKSAR and CHAN Ka Yiu* and *HKSAR and Leung Lok Yi* (CACC147/2016). In this most recent case, the court cited and affirmed Joe-Laidler's report [5.4] The Honourable Justice of Appeal of the Court of Appeal, Kevin Zervos, stated, "her evidence was of critical importance in the formulation and structure of sentencing guidelines for offenders of drug trafficking in ketamine… She is regularly called upon to provide expert evidence…" This view has also been expressed by the presiding judge in the precedent setting case, the Honorable Mrs. Justice Barnes, Judge of the Court of First Instance of the High Court. [5.6-5.7]

2. Change in professionals and practitioners, programs and policies from drug policy and harm reduction training in Asia
Since the start of this research program, the findings have been published in a range of international, regional and local venues – from academic journal articles to invited talks and public engagements to radio interviews and other forms of social media. As a result of this dissemination, Joe-Laidler has been a key partner in the development of a global network of drug policy advocates (https://www.facebook.com/groups/650765401732435/), and in collaboration with the Open Society Foundations (OSF), launched, in 2015, a drug policy and harm reduction training program for those working in the drug arena in the Southeast Asia region. The group

includes policymakers, law enforcement, lawyers, judges, drug treatment workers, cultivators (farm growers), and other NGOs. This annual initiative provides these diverse professionals to network, develop a knowledge base about the challenges and problems with drug policies, and the importance of health and harm reduction considerations in drug policy. The training program has developed a network of 98 alumni to provide support in advocacy and change. As OSF's testimonial indicates, this training has been impactful at the international level by preparing regional stakeholders – government and civil society- with the necessary knowledge to engage in the negotiations of the 2016 UN General Assembly Special Session on drugs and at the regional level – in building civil society capacity for evidence led policymaking [5.8]. This is particularly the case with alumni from the Philippines, a) who have joined together (as a result of our network) to work with legislators on drafting Senate bill 1313, b) led one of the key civil society organizations – NoBox - to take a key role in education and advocacy of harm reduction in the country, c) led to the establishment of Street law PH (three alumni who joined from the program) providing legal aid for drug users, technical advice on policy advocacy, developing strategic litigation, and educating law students on drug related issues, and d) led one alumni to produce investigative reports/documentaries on the drug related issues and harm reduction [see also alumni testimonials in 5.9]. Alumni Navallo's testimonial indicates the training was and instrumental to his ongoing series of documentaries and networking in the Philippines (https://www.youtube.com/watch?v=nSgC--oJ4_8; ; https://www.youtube.com/watch?v=rzpJ33ho4iw&feature=youtu.be%29; https://www.youtube.com/watch?v=HZeKzxLaJcE; https://www.youtube.com/watch?v=qD3686vDFjo) [5.9] Myanmar alumni have also developed programs to assist subsistence level farmers of opium, a community based advocacy project for marginalized youth, and capacity building efforts for farmers to engage directly in policymaking. This initiative has also led alumni to work and develop capacity cross regionally as alumni in Beijing (Asia Catalyst) meeting with opium farmers in Myanmar and in planning projects related to HIV prevention, PrEP, and mobile apps for harm reduction [5.8-5.9].

3. Improved community drug treatment services in local community
Local NGOS have also sought assistance in evaluating and advising on drug treatment services. Evaluations with small and large NGOS (e.g., Barnabas and the Society of Rehabilitation and Crime Prevention [SRACP]) have provided timely information for addressing the specific needs of psychotropic drug users taking into account gender, age and spiritual needs. SRACP, the largest Hong Kong NGO service provider for rehabilitation and treatment for (ex) prisoners, has adopted our recommendations for strengthening services, and found them to be effective (5.10).

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1 Court judgement and case reporting/citing expert witness testimony in High Court, Court of First Instance *HKSAR v HII Siew Cheng* (HCCC 121 of 2005) and Case Report

5.2 Court judgement reporting/citing expert witness testimony for the Court of Appeal *Hii Siew-Cheng (CAAR 7/2006)* and Review report of said case.

5.3 Secretary for Justice and Hii Siew Cheng (Court of Appeal: Application for Review No. 7 of 2006 and Criminal Appeal No. 126 of 2007) Hong Kong Law Reports and Digest (2009) HKLRD p. 1-34.

5.4 Court judgement reporting/citing expert witness testimony in *HKSAR and CHAN Ka Yiu and HKSAR and Leung Lok Yi (CACC147/2016)*

5.5 Archive of 681 cases citing precedent case in which expert witness testimony given

5.6 Testimonial from Justice K. Zervos (Justice of Appeal, Court of Appeal), and at the time of *Hii Siew-Cheng (CAAR 7/2006)*, was the prosecuting counsel.

5.7 Testimonial from Presiding Judge Justice J. Barnes (Judge of the Court of First Instance of the High Court) in *Hii Siew-Cheng (CAAR 7/2006)*

5.8 Testimonial from Open Society Foundations

5.9Testimonial from harm reduction training participants throughout Southeast Asia (7)

5.10 Testimonial from largest Hong Kong NGO service provider for treatment and rehabilitation on changes made in services and its' effectiveness (1)

University: The University of Hong Kong

UoA 18 – Planning and Surveying (land and other)

Title of case study: Spatial Design Network Analysis (sDNA): improving design analytics for evidence-based planning and design

1. Summary of the impact: HKU Faculty of Architecture's (FoA's) next generation spatial network analysis software is directly contributing to making urban spaces more sustainable in some of the world's most dynamic cities. In Shanghai, Paris, London and Hong Kong (HK) urban designers have used HKU's sDNA to generate analytical evidence in arguing for more pedestrian and walking orientated space in their designs. We estimate that sDNA-enabled projects may have benefitted up to 5 million residents by offering viable well-planned alternatives to car use. In another domain, sDNA has also been applied innovatively in public health analytics by the UKBioBank. Our claim in this respect, is that we have completed the modelling power of the UK's flagship epidemiological cohort by adding 700 high resolution, objectively measured built environment (BE) metrics for each of the cohort's half a million subjects. The UKBiobank is now the only national level cohort to have a wide range of accurate measures covering all 4 pathways to impacts and prediction of disease: gene + built, natural and social environment. Our claim of impact is in the creation of a platform that for the first time, allows public health analysts to build standardised measurements of the BE into their models of healthy cities. sDNA exists as standalone freeware or free plugin for proprietary software.

2. Underpinning research: This falls into two categories: (a) research into the underlying science of the relationship between network analysis and urban performance and (b) computation and technical research that implements models of urban network analysis suitable for scientific and professional use. These are elaborated as follows.

(a) sDNA quantifies and compares the relative efficacy of urban network layouts for any type of movement, be it pedestrian, cycle, road or rail. FoA researchers have made a major contribution to establishing that a city's socio-economic performance, focusing particularly on 'wealth and health', is strongly statistically associated with the configuration of urban road and pedestrian movement grids (1 to 6) among many other studies. Our papers have used large-number studies (for statistical power) to show the associations between network design characteristics and performance outcomes such as individual health **[4-5]**, property prices, housing sub-market formation **[1]**, street walkability, social and transactional opportunities **[6]**, traffic externalities **[3]**, 3-dimensional urban design performance **[2]**, and the effectiveness of green spaces on walking choice and health **[5]**. We have shown with high levels of scientific confidence, that the geometric and topological configurational information that sDNA measures, can be used as a proxy for such urban socio-economic performance dimensions. Our research into the urban science of sDNA's network analytics has allowed us to publish papers in leading science journals such as Lancet Planetary Health, for example on the influence of urban design on Type II diabetes, obesity, mental health, cardio and pulmonary disease; and also to publish in all the top urban journals on the influence of sDNA-measured network design on people movement, urban land values and the use of the tool predictively to analyse plans and designs for performance. Without this underlying research, there would be no case to make in disseminating sDNA software to practitioners.

(b) Second is the computational and technical research behind sDNA. Our team's contribution is significant in the world of urban design and transport analytics because it improves on the 3-decade old established market-leader, UCL's successful Space Syntax urban network software. Space Syntax was built to support architectural urban design work. It was lacking transparency in its code, scientific credibility, industry-standard representation methods, advance geometric analysis features, suitability for 3D analysis and so on. **sDNA was built to address such issues and provide a brand new approach for urban design analytics while at the same time providing a scientifically credible tool to use in the fast growing interface between urban design and public health.** Specifically, we highlight the following underlying computational research and development. An early version of sDNA was first released 2012, when three of the HKU research team were at

Cardiff University. The team moved to HKU between 2013 and 2016 and with new funding, sDNA released innovations starting from november 2014, that included the following: (i) Native use of industry **standard data model** structures and representation – link geometry-node empirically tested in 2D [3], in a form that can be used across urban planning and design professions; (ii) sDNA's advances and adoptions were shared as part of an innovative 3-level transport analysis framework, to industry professionals at the 11th, 12th and 13th Annual UK Transport Practitioner Meeting, Birmingham (2013), London (**2014, 2015**) and at international conference Walk 21, Munich (**2014**), Vienna (**2015**) and HK, European Transport Conference Frankfurt (**2014**) with more than 500 delegates from health, transport and planning professionals; (iii) to make it easy to use for designers, a "true" 3D representation and analysis was developed and empirically tested [2], this being particularly important in multi-level vertical cities, steep topography, and vertical multi-level complex mixed use Transit Oriented Developments (TODs) increasingly used as a core planning strategy across the world; (iv) **a unique hybrid network centrality metric** was designed, combining Euclidean & Geometric measures, which outperformed previously used metrics empirically [2] and **is more consistent with wayfinding theory; (v) sDNA was tested in the building of a 2D/3D** link-node detailed pedestrian mapping at city scale for the study of city-wide of connectivity, accessibility and walkability covering the whole of HK [2], co-produced with HK Government's Lands Department and adopted by them as the model used for active travel planning in HK.

Staff at HKU (**Webster C.**, Chair Professor in Urban Planning and Development Economics, HKU 2013-present, Cardiff University 2013-00. **Chiaradia AJF.** Associate Professor in Urban Design, HKU 2016-present, Cardiff University 2010-16, UCL 2000-09. **Sun G.**, Assistant Professor, HKU 2016-present. **Sarkar C.,** Assistant Professor of GIS, Urban Health and Environment, HKU 2014-present, Cardiff University 2010-2014) have conducted a series of competitive externally and internally funded research projects structured within the team's original economic theory of accessibility and its own original spatial epidemiology and public health theory of accessibility [5]. This research commenced at Cardiff University in 2010, received funding from an ESRC Transformative Research grant (2013), which was administered from HKU, and has involved collaborations at the following universities: Cambridge and Oxford (medical schools), HKU, Shenzhen, and Tongji in Shanghai, and with planning and transport consultants such as WSP and ARUP UK and HK, Civic Exchange (HK NGO promoting quality BE and walkability) and HK Government Departments (Lands, Planning and Transport).

3. References to the research

1. Xiao Y Orford S **Webster C**, **2016**, Urban configuration, accessibility, & property prices: a case study of Cardiff, Wales. EPB: City Science & Urban Analytics 43(1) 108-129. DOI
2. Zhang L, **Chiaradia A**, **2019**, 3D spatial design network analysis and its application in a high-density city area, Central Hong Kong, Urban Planning International, 34(1), 46-53 DOI
3. Wedderburn, M. and **Chiaradia, A**., **2014**. Network, Network, Network: New Techniques in Pedestrian Movement Analysis. In 42nd European Transport Conference, Association for European Transport (AET), 10-17 Sept. Frankfurt, 1-13. **Co-I SPPR research 2017**-20.A7.004.17S **HK$ 3.5m**, for **Strategies for Enhancing Walkability in Hong Kong via Smart Policies**
4. **Sarkar C**, Gallacher J and **Webster C, 2015,** UK Biobank Urban Morphometric Platform (UKBUMP) – a nationwide resource for evidence-based healthy city planning and public health interventions. ***Annals of GIS***, 21(15), 135-148. DOI **2014 RTPI Research Excellence Award.**
5. **Sarkar C** and **Webster C, 2017**, Healthy Cities of Tomorrow: the Case for Large Scale Built Environment–Health Studies, Journal of Urban Health 94(1), 4-19 DOI
6. **Sun G, Webster C, Chiaradia A, 2017**, Ungating the city: a permeability perspective. Urban Studies, 55(12), 2586-2602. DOI

4. Details of the impacts

sDNA, supported by its underlying research, is being used to provide analytical evidence globally in support of policy and design that is more friendly on the environment, healthier for city

inhabitants, economically more beneficial for retailers and home-owners, and more consistent with lively, viable urban streets and spaces. Since releasing sDNA for open source Geographical Information System (QGIS) at the beginning of 2016, the annual rate of new licence registrations tripled between 2014-16. By 2018, the number of sDNA-QGIS software/license downloads has increased 20-fold to ≈ 12,000 compared to 17,500 for Space Syntax, the long-established urban design analytics software that sDNA benchmarks against. The geographical split of downloads is global: Europe (22%), China (16%), North America (6%), with the remaining 56% spread globally.

1) **Examples of Hong Kong impact**. While HK has one of the highest metro ridership rates in the world, has given the world its famous model for land-based transit investment finance through high density development around stations (TODs), and has a highly dense pedestrian network, until 2017 it was without a pro-walking policy or an underlying data-platform to support such a policy. **FoA's walkability team, using sDNA technology, have provided that platform**. In 2016, for the first time in Asia, the international conference Walk21 promoting walkability worldwide was organised in HK. This event was attended by the Government Chief Executive who made a policy pledge on Walkability. The sDNA-enabled WalkableHK project, the World's first 3D digital pedestrian route-map for an entire city, won the prestigious Walk21HK CityTech Awards. In 2017, the Chief executive's committed to improving walkability across HK. This was followed by a range of walkability consultancy commissions. Our FoA team, in partnership with HK Lands Department (LandsD) (with a HK$ 1.4M contract), developed a 3D integrated outdoor-indoor pedestrian network map for healthy city modelling for the whole of HK. This geo-database, handed over by HKU to LandsD early in 2019 is the de facto pedestrian digital standard infrastructure for HK's Transport (TD) and Planning Departments (PlanD) walkability initiatives for the benefit of the whole of HK for many years to come **[A]**. Relatedly, transport consultancy MottMac (HK$ 14m) and ARUP HK (HK$ 7m) commissioned by TD & PlanD formulate a planning and design standard based on pedestrian-first principles for developing HK into a more walkable city, are using our 3D sDNA-enabled pedestrian network model of Central HK. Our model is being used to prototype and test: 1/ walkability improvement impacting daily on more than 1 million people as part of a 3-year HK wide walkability, 2/ a Pedestrian Connectivity Application Programming Interface platform to appraise all future pedestrian projects **[B].** Collaborating with Cistri, at another scale and with a different kind of partner, sDNA informed the first "Places Impact Report" (2019) of Swire Properties, a leading international property developers and global sector leader in Global Real Estate Sustainability Benchmark. The study focused on office-led TODs in Taikoo Place areas in HK (100,000 people). As a pilot impact methodology, it is guiding Swire Properties future 'place' developments in HK and worldwide **[F]**.

2) **Examples of Mainland China impact**. sDNA is also being used more widely in China. Chinese urban planners operate mostly with intuitive design skills, which are insufficient for planning very high density, complex multi-level Transit Oriented Developments in a mixed-market land economy. The attraction of sDNA to China's urban planners is its ability to predict urban system performance, including pedestrian and car traffic volumes, land use demand at different points in the urban grid, land values, and tantalisingly from our epidemiological studies, urban health outcomes. sDNA analysis provides the "proofing" of strategic plans at all scales and stages, from early on in the process of urban planning and design to modifications at the time of consultation and implementation. Tongji University planning and design institute (**TJUPDI Shanghai**) and **Shenzhen University Design Institute** consultants, are **currently** using sDNA to evaluate accessibility and economic performance of TODs **[D]**. As a result, many implemented urban master plans have included more walkable urban grids, which will remain in China's cities for decades if not centuries to come. These two institutes are huge players in Chinese master planning, with TJUPDI (established in 1996 as a practice based platform of Tongji University) having over 200 hundred full-time urban planners and designers who have prepared about 40% percentage of master plans for China's major cities. Tongji University has co-funded some sDNA technical refinements for 3D urban design. We cannot prove the efficacy of sDNA in TJUPDI or SUDI projects but

present this collaboration as evidence of providing a scientifically validated urban analytics tool kit for one of the most prolific and respected master planning agencies in the world and as we have said, we can claim that sDNA has hard-wired more walkable, sustainable, healthy environments into Chinese cities for generations to come.

3) **Example of European Impact**: sDNA has been used by consultants BRS (France) and dEp (UK) commissioned by the Transport Planning Authority of St Quentin-en-Yvelines **[C]**, (150,000 inhabitants) to appraise walking and cycling investment plans. The sDNA-enabled applied research involved the creation of a 1,400km pedestrian network model as a basis for a road-transport community severance study. An sDNA-enabled routing app was developed for impaired people (visual, physical or cognitive), which won the 2014 Paris-based Mobility Award. The 15 years investment plan aimed to reduce urban rail infrastructures severance around TODs for pedestrians and cyclists. sDNA analysis showed that the compounding of cycling and walking investments was not effective for pedestrian. Our analysis prevented the construction of ineffective pedestrian infrastructure and prevented the wasting of resources for many decades to come.

4) **sDNA's impact on Public Health analytics**: sDNA has been used by the **UK Biobank** project based at Oxford University to introduce objective and standardised BE indicators into analytical epidemiological models and public health debates. The UK Biobank is a major national and international health policy and science resource. It aims to improve the prevention, diagnosis and treatment of a wide range of serious and life-threatening illnesses through data on 500,000 people. A UK Biobank grant (**2013-2017**), run from HKU FoA, enabled sDNA-based production of a uniquely accurate set of BE metrics (epidemiology-modelling quality) for each of the Biobank's 500,000 cohort members. According to Nature, UK Biobank creates an "unprecedented open access database that has enabled an order of magnitude larger studies on genetic and epidemiological associations for an extensive range of health related traits" and opens "a new era of health research". The contribution we claim in this part of the case study is that our sDNA team has converted the UK's flagship national epidemiology cohort study into a full gene-environment {Built, Natural, Social environment} platform. This is something of a holy grail for public health analysts, practitioners and policy makers, since it covers the four principal pathways to health/poor health. A scientifically-credible set of high resolution BE metrics describing the activity space around each cohort member's home, had never been included in such a large national study; no study globally has this quality of BE data in a form that can be matched with individual health records and subjects' personal dna. We cannot prove the impact of the sDNA-enabled UKBiobank platform on health (apart from quoting scientific papers that use the Biobank's BE data), but we can cite our contribution to UK Biobank as evidence of **sDNA's impact on creating a globally unique and path-breaking public health data platform**. This contribution was completed in 2017 and evidential BE studies are starting to emerge. sDNA-enabled epidemiology models have been used by healthy city analysts and reported in leading health journals widely read by health officials and practitioners (e.g. BMJ, Lancet Planetary Health). As an adjunct to sDNA's impact on the UKBiobank platform – adding BE measures to complete its capacity to support 4-pathway epidemiology studies - we therefore want to draw attention to our work's impact on another field of applied science and policy making and note that sDNA-enabled public health findings have been widely reported in the press and used by NGOs to promote their healthy city agenda.

5. Sources to corroborate the impact: A. 2017, Transport Housing Bureau Walk Initiatives and Smart City Blueprint. Chiaradia Walkability expert at Civic Exchange. LandsD contract.

B. MottMac testimony (tb coll.) and ARUP UK and ARUP HK

C. Testimony from St. Quentin en Yvelines planner, confirms the use and usefulness of sDNA in planning and urbanism projects in Paris (tb coll.).

D. Testimony from Shanghai Tongji Design Institute (TJUPDI) and Shenzhen Design Institute (SUIAUPDR) confirms the use of sDNA for proofing strategic spatial planning in Chin.

E. Testimony of an independent transport professional confirms the wide transport professional use sDNA for sustainable transport planning and design in the UK and abroad.

F. Swire/Cistri scope of work KE contract.
G. BioBank (tb coll.).

University: The University of Hong Kong

Faculty: Faculty of Science

Title of case study:

Reduction of illegal global wildlife trade through novel conservation forensics research

(1) Summary of the impact (indicative maximum 100 words)

Conservation research undertaken at The University of Hong Kong (HKU) allowed increased enforcement of national and international law protecting endangered species and supporting illegal wildlife trade reduction. Conservation actions stemming from this research resulted in increased protection of turtles, pangolins and fish under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and via the International Union for Conservation of Nature (IUCN). Further, newly developed forensics techniques uncovered extensive criminal activities and supporting successful prosecution. As Hong Kong is a global hub for wildlife crime, this research has led to significant reductions in illegal trade.

(2) Underpinning research (indicative maximum 500 words)

The annual illegal trade of protected wildlife is estimated to be worth 5 to 20 billion (US Dollars) globally, with demand originating largely from Asia. As many of these illegal wildlife activities have been linked to other criminal activity, identifying and restricting this trade is of global concern. Research focusing on wildlife trade within the School of Biological Sciences at HKU encompasses over a decade of multidisciplinary work with impacts that have successfully affected policy and increased protection for species. Hong Kong is a global hub for wildlife trade due to free trade laws allowing import, export and re-export of wildlife products into the rest of Asia, for purposes such as Traditional Chinese Medicine and the pet trade. Specifically, a number of species have been put forward to CITES in petition for their increased protection against trade. Prof. David Dudgeon of HKU documented the high number of illegally traded Asian turtles in markets across southern China and strongly highlighted the need for protection (3.1). This research was used to support a proposal for increased protection of both Trionychidae and Platysternidae freshwater turtles by moving species from Appendix II to Appendix I of CITES, the highest form of protection provided by the international convention.

Further research successfully influenced the increased protection of Sunda and Chinese pangolin species from listing in Appendix II to that of Appendix I in CITES in 2016. All eight species of pangolin are now listed on the International Union for Conservation of Nature (IUCN) Red List, as they are highly sought after in Asia for their scales and meat. Research by Prof. Richard Corlett (3.2) (at HKU from 1988 to 2008) highlighted the large-scale negative impacts of hunting impacts on wild populations of pangolins and other mammals across Asia.

In 2016 building upon HKU's history of monitoring illegal trade and the impacts on wild populations (3.1 and 3.2), the Centre for Conservation Forensics (CCF) at HKU was established to investigate the wildlife trade (https://www.ccf-hku.com). CCF developed a range of molecular and isotopic forensics and data analytical tools for countering wildlife crime. These enabled Dr. David Baker (at HKU from 2012 to present) to gather the first evidence of illegally traded European eel into Asia and Hong Kong (3.3) by genetically identifying glass eels (juveniles of the endangered European eel) intercepted by Hong Kong Customs, leading to successful prosecution. Furthermore, social network analysis (3.4) of Chinese seizure data of pangolins led by Dr. Timothy Bonebrake (at HKU from 2012 to present) supported increased protection of pangolins under CITES and IUCN along with the earlier work detailing impacts of hunting by

Prof. Corlett (3.2). Finally, while Prof Dudgeon's research quantified illegal turtle trade in physical markets (3.1), Dr. Yik Hei Sung (at HKU from 2018 to present) quantified the immense online trade in turtles and provided management recommendations for the emerging and critical trade of species on the internet (3.5).

(3) References to the research (indicative maximum of six references)

HKU principal investigators are in **bold**. Citation data from Google Scholar Feb 2019.

(3.1) Cheung SM, **Dudgeon D** (2006) Quantifying the Asian turtle crisis: market surveys in southern China, 2000–2003. *Aquatic Conservation*, 16, 751-770. DOI: 10.1002/aqc.803 *(Cited by 125)*

(3.2) Corlett RT (2007) The impact of hunting on the mammalian fauna of tropical Asian forests. *Biotropica*, 39, 292-303. DOI: 10.1111/j.1744-7429.2007.00271.x (*Cited by 371)*

(3.3) Stein FM, Wong JCY, Sheng V, Law CSW, Schroder B, **Baker DM** (2016) First genetic evidence of illegal trade in endangered European eel (*Anguilla anguilla*) from Europe to Asia. *Conservation Genetics Resources*, 8, 533-539. doi:10.1007/s12686-016-0576-1 (*Cited by 2)*

(3.4) Cheng W, Xing S, **Bonebrake TC** (2017) Recent pangolin seizures in China reveal priority areas for intervention. *Conservation Letters*, 10, 757-764. doi:10.1111/conl.12339 *(Cited by 12)*

(3.5) Sung YH, Fong JJ (2018) Assessing consumer trends and illegal activity by monitoring the online wildlife trade. *Biological Conservation*, 227, 219-225. doi:10.1016/j.biocon.2018.09.025 *(Cited by 1)*

(4) Details of the impact (indicative maximum 750 words)

Impact on CITES protection of species

Conservation research undertaken in the School of Biological Sciences at HKU has provided information influencing proposals made to CITES for the increased protection of species threatened by trade. Global wildlife trade hotspots include those countries bordering China, but in particular Hong Kong, as it practices free trade and is home to the world's busiest cargo airport. For to these reasons, CITES makes more seizures along this border than any other border with China. To highlight these issues to the public and authorities, and thus influence policy, Prof. Dudgeon quantified the turtle trade in southern China (3.1), identifying multiple threatened species being sold in food markets, Traditional Chinese Medicine and in the pet trade in Hong Kong. These results were used in the official CITES proposal for the amendment of Appendices I and II in the 17th meeting of the Conference of the Parties in Sept 2016[1]. **The work was successful in the listing of two softshell, freshwater turtles in the Trionychidae family, *Cyclanorbis elegans, Cycloderma frenatum* into Appendix II of CITES**[2]. Trade of this turtle family within China was not subject to CITES regulations prior to this case. Prof. Dudgeon's work was also influential in the successful proposal[3] and subsequent **increased protection of the big-headed turtle (family Platysternidae) from Appendix II to I, the highest trade protection available from CITES**[3]. The species became subject to global enforcement of trade in Sept 2014.

Prof. Corlett's research (3.2) on the impact of hunting mammals inhabiting Asian rainforests drew attention to the fact that exploitation of the two Asian species of pangolins for international trade was unsustainable and largely illegal, and presented the case for greater enforcement[4].

Trade in pangolins has been prevalent in China for medicine and food for centuries, with the results of this poaching being a dramatic recent decline in abundance, with all species of Asian and African pangolin now listed as either "Vulnerable", "Endangered" or "Critically Endangered". Further study on trade networks of pangolins in China (3.4) provided vital information for a report by the wildlife trade non-governmental organization, TRAFFIC[5]. **These studies were then influential in contributing to the successful proposals of up-listing and increased protection of Sunda and Chinese pangolins from Appendix II to I** in the 17th Conference of Parties for CITES in 2016[4,5]. All pangolin species are now subject trade regulation and, specifically, all international trade of pangolin meat and scales is illegal with increased enforcement and greater penalties for violation of the law.

Impact on wildlife crime law enforcement

The CCF at HKU provides a professional DNA identification service for a Hong Kong government's Agriculture, Fisheries and Conservation Department (AFCD). A case of suspected European eel importation was referred by Hong Kong Customs, and samples provided to the CCF lab for analysis. Through the analyses of the CCF lab, this case proved to be **the first genetically verified importation of the CITES listed "Critically Endangered" European eel (*Anguilla anguilla*) into Hong Kong,** leading to a successful publication in collaboration with members from the Sustainable Eel Group in Europe (3.3). This work highlighted the illegal global trade of the endangered European eel (*A. anguilla*) to Asia. The rapid analysis of samples, with evidence provided to HK Customs by the CCF lab, and publication provided **led to a successful prosecution in 2016**[6]. These actions highlight the role that the CCF lab played in **improving the effectiveness of the enforcement of wildlife crime law in Hong Kong.**

(5) Sources to corroborate the impact (indicative maximum of 10 references)

[1] **2016 proposal for up-listing species of Trionychidae cites Cheung and Dudgeon (2006):** https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-36.pdf

[2] **2016 proposal was successful:** https://www.turtleconservancy.org/news/2016/10/17th-conference-of-the-parties-to-the-convention-on-international-trade-in-endangered-species-of-wild-fauna-and-flora

[3] **2014 successful proposal for up-listing species of Platysternidae cites Cheung and Dudgeon (2006) and went into effect:** https://www.fws.gov/international/cites/cop16/cop16-proposal-appendix-i-listing-of-big-headed-turtle.pdf

[4] **2016 proposal for up-listing Sunda and Chinese pangolins from Appendix II to I cites Pantel and Anak (2010):** https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-*11.pdf*
which uses and cites Corlett (2007): http://www.pangolinsg.org/wp-content/uploads/sites/4/2016/06/Pantel-and-Anak2010-Preliminary-assessment-of-Sunda-pangolin-trade-in-Sabah_TRAFFIC-SE-Asia.pdf

[5] **Analysis by Cheng et al. (2017) informed Xu et al. (2016):** [see **pdf1** of email from coauthor of the paper], http://static1.1.sqspcdn.com/static/f/157301/27254615/1474377211627/Pangolin-trade-in-China-briefing-paper.pdf?token=M5KBFGwWkxTNgmLB2rCX4AxNYzs%3D

[6] Evidence in **Stein et al. (2016) was used in the successful prosecution by Hong Kong government in 2016**: [see **pdf2** of email from AFCD]

Annex II

Quantitative Indicators

Table 1

Performance Indicators Laid Down by UGC	2019/20
Number of patents filed in the year (with breakdown by country and type) Note 1	186 Note 2
Number of patents granted in the year (with breakdown by country and type) Note 1	67 Note 3
Number of licenses granted (with breakdown by type) Note 1	133
Income (on cash basis) generated from intellectual property rights	$29M
Expenditure involved in generating income from intellectual property rights Note 4	$9.7M
Number of economically active spin-off companies (with breakdown by type) Notes 1 & 5	34
Net income generated (or net loss arising) from spin-off companies Note 6	($55.7M)
Number of collaborative researches, and income thereby generated Note 7 - no. of projects - income generated	 43 $37.20M
Number of contract researches (other than those included in "collaborative researches" above), and income thereby generated Note 8 - no. of projects - income generated	 995 $470.59M
Number of consultancies, and income thereby generated Note 9 - no. of projects - income generated	 1,059 $67.44M
Total of collaborative researches, contract researches and consultancies Note 10 - no. of projects - income generated	 2,097 $575.23M
Number of student contact hours in short courses or e-learning programmes specially tailored to meet business or continuing professional development (CPD) needs Notes 11 & 12	7,088,116

Performance Indicators Laid Down by UGC	2019/20
Income received from CPD courses Notes 11 & 13	$688M
Number of equipment and facilities service agreements, and income thereby generated - no. of agreements - income generated	 38 1.48M
Number of public lectures/symposiums and speeches to a community audience Note 14	986 Note 15
Number of performances and exhibitions of creative works by staff or students Note 14	91 Note 15
Number of staff engaged as members of external advisory bodies including professional, industry, government, statutory or non-statutory bodies	564

Notes:

1. The number of patents granted is unrelated to the number of applications in a particular year.
2. The number of inventions involved is 139.
3. The number of inventions involved is 54.
4. The costs incurred in protecting all IPR in the reporting year are reported, without limiting only to those patents that were successful in generating income.
5. For commercialisation, the University through Versitech takes a dual approach of spin-off and licensing. In addition to spin-off companies, start-ups that are commercialising HKU technologies and funded by the Technology Start-up Support Scheme for Universities at HKU (TSSSU@HKU) have been included.
6. Versitech, HKU's wholly owned technology transfer company, is a minority shareholder in the spin-off companies. It is difficult to predict the companies' sales/turnover due to the volatile business environment. Only the net income (or net loss) of those companies with equity held by Versitech was reported because being the equity holder Versitech could obtain the financial information from those companies.
7. ITF projects with industrial sponsorship and other collaborative projects with at least two partners (one of which being a government or public body) were included.
8. Contract research projects commissioned by external organizations, and projects supported by funding schemes that allow non-higher education institutions to apply, including ITF projects without industrial sponsorship, Public Policy Research projects, and projects funded by the Food and Health Bureau, the SK Yee Foundation, Construction Industry Council, and Standing Committee on

Language Education and Research (SCOLAR), were included. NIH projects have been classified as Contract Research since 2016/17.

9. Consultancy and service projects for KE commissioned by external organizations to the University or Versitech, and consultancies undertaken by individual staff as outside practice (excluding clinical service and teaching in other tertiary education institutes) were included.
10. It is considered more appropriate to group collaborative researches, contract researches and consultancies together because it is sometimes not easy to classify projects into these categories.
11. Starting from 2018/19, the number of CPD courses includes self-funded Ug/TPg programmes and programmes offered by HKU School of Professional and Continuing Education (HKUSPACE) which are identified as for CPD purpose in accordance with the definitions of CPD set out in UGC's Common Data Collection Format (CDCF).
12. The figure of 2018/19 was adjusted to reflect the change of the calculation method of contact hours in 2019/20. There was a significant increase of the contact hours in 2019/20 because of a new course under HKSPACE with exceptionally heavy contact hours.
13. Income on a net basis was provided.
14. Community, cultural and KE-related events organised by the University and those delivered by academic staff at the invitation of external organisations were included.
15. The ongoing COVID-19 pandemic had a major effect on public engagement, resulting in a drop in the numbers of public events and performances in 2019/20.

Table 2

Other Performance Indicators of HKU	2019/20
Number of external advisory bodies membership held by HKU staff	2,739
Number of knowledge transfer websites Note 1	322
Number of postgraduate theses on open access Note 1	28,123
Download count of postgraduate theses to addresses outside HKU Note 1	248,336
Number of publications on open access Note 1	29,196
Download count of publications to addresses outside HKU Note 1	1,361,195

Other Performance Indicators of HKU	2019/20
View count of HKU Researcher Pages from outside HKU Note 1	6,765,004
View count of HKU Research Postgraduate Student Pages from outside HKU Note 1	114,054
Number of staff available for media contact	678
Number of placement/internships Note 2	3,463
Number of mentors from outside HKU for HKU students Note 2	1,002
Number of appointments of external members to HKU advisory boards, committees or panels Note 2	379

Notes:

1. These seven indicators refer to the University's efforts in making knowledge accessible to society.
2. As HKU sees KE as a two-way process, these three indicators refer to the University's efforts to learn from the community.

October 31, 2020