Research Assessment Exercise 2020

Impact Overview Statement

University: The Hong Kong University of Science and Technology

Unit of Assessment (UoA): 16 - Civil Engineering and Building Technology

Total number of eligible staff of the university in the UoA: 28

(1) Context

Research in the Department of Civil and Environmental Engineering, which comprises this Unit, has had significant ***economic, social, regulatory, environmental,*** **and** ***professional impacts*** in areas covering geotechnical engineering, construction management, transportation, materials, hydraulics, and structural engineering. We deliver impact through providing practical solutions to infrastructural needs and informing guidelines in Hong Kong, and wider society, in traditional civil engineering domains, such as utilities and construction, as well as multidisciplinary areas including smart cities, hazard prevention and safety, green construction, and energy and environment. Primary users are:

- **Governmental bodies:** e.g. HKSAR Drainage Services Department, Geotechnical Engineering Office, who deploy our cutting-edge eco-friendly and cost-effective technologies in public works (e.g. stormwater storage, sewage treatment, slope safety – GH Chen, A Lau, J Lee, Ng, YH Wang, L Zhang) impacting households, the environment, and overall community.
- **Industry:** Collaboration and consultancies for major companies (e.g. AECOM, Ove Arup, Black & Veatch), SMEs and fostering start-ups, impacting the economy. Areas range from optimized tall building designs (C Chan) to advanced composite cement-based materials (Z Li, CK Leung).
- **Built-environment practitioners:** Our research outcomes have been adopted in codes of practice, which have substantially improved professional practices locally and overseas. Examples include: the Code of Practice on Wind Effects in Hong Kong; Guide to Soil Nail Design and Construction; and international standard ISO2394 (General Principles on Reliability of Structures): 2015.

Other beneficiaries include construction-related firms, hazard mitigation organizations, licensees of our technologies, regulators, policymakers, and the public in and beyond Hong Kong.

(2) Approach to impact

Our vision is to be a world leader in civil and environmental engineering research and education, with significant international impact and strong local commitment in serving society's needs. Over the review period, UoA mechanisms to facilitate impact included:

- **Close working relationships with government and industry:** These associations have assisted faculty in developing practice guidelines; identifying industrial needs and monitoring research directions and feedback; accessing government data; and facilitating field testing and investigations in major engineering projects. E.g. Happy Valley underground stormwater storage scheme employing real-time control systems (J Lee) with the Hong Drainage Services Department, risk-based decision tools in mountain highway design (Ng, L Zhang/Sichuan Department of Transportation).
- **Applied research centers for knowledge transfer**: UoA faculty lead prestigious research centres that foster application of breakthroughs. E.g. Hong Kong Branch of the Chinese National Engineering Research Center for the Control and Treatment of Heavy Metal Pollution (2015, led by GH Chen) and deployment of breakthrough wastewater/water treatment processes; HKUST-DIDI Joint Research Laboratory (2017), ride-sourcing data-driven analytics sponsored by ride-sharing giant Didi Chuxing, which has 400M users in over 400 Chinese cities, (H Yang, also Lab coordinator); and state-of-the-art Geotechnical Centrifuge Facility (L Zhang) and CLP Power Wind/Wave Tunnel Facility (Tse, Lam), which verify innovative tall building designs and green slope designs for academic and industry users.
- **Patents:** leveraging the University's HKUST R and D Corporation Limited and Technology Transfer Centre, the Unit has filed 93 patent applications over the review period, with five of our technologies licensed to four companies based in Japan, The Netherlands, HKSAR, and Shenzhen, mainland China, respectively. In a further indication of our growing external partnerships, Hong Kong **private company and non-local support** for Unit research reached HK$5.1M per year and HK$9.3M per year respectively in this review period, about 3.5 times more than RAE2014.

● **Entrepreneurship and start-ups:** The Unit has generated two start-ups over the review period (Blue Innowater Co Limited, GH Chen, faculty; INNOWAT Limited, WQ Xue, student), with the help from the Technology Start-up Support Scheme for Universities (TSSSU).
● **Policy, professional services and dissemination:** The University-wide GREAT Smart Cities Institute (2018, previously a Centre) led by H Lo is driving applied multidisciplinary projects, including strategic public policy research on urban walkability in Hong Kong (H Lo). Our faculty have also sat on several advisory committees over the review period (e.g. Code of Practice on Wind Effects in Hong Kong, Tse; Code of Practice for Foundations, L Zhang and G Wang); and made numerous media appearances as technical experts (e.g. BBC News – GH Chen).
● **Successful application for major government and other grants:** Focused on original research and societal impact, such as the RGC Areas of Excellence Scheme (Ng, extreme weather prediction, HK$91.85M); Theme-based Research Scheme (Ghidaoui, smart urban water supply systems, HK$33.2M; GH Chen, paradigm-shifting wastewater-to-resource facility, HK$35.6M; Ng, green technologies to mitigate debris flow risks, HK$33.2M); HSBC 150th Charity Anniversary Programme (A Lau, personalized air quality informatics, HK$46.15M).
● **Advancing our impact culture**: All the above are facilitated by the Unit's on-going development of an internal culture that makes it clear to faculty that impact is a significant component of research achievement. Mechanisms include recruitment of new staff in high-impact areas; inclusion of research impact as a criterion for staff development, promotion and performance review; internal funding for projects with impact; a mentoring system for early career researchers; and an entrepreneur program (WQ Xue) to help research students to recognize impact as an important part of their research.

(3) Strategy and plans

Our future research impact strategy will be built on the successful methods above as well as fresh measures enabling the UoA to play a leading role in Hong Kong-Guangdong-Macao Greater Bay Area development and to assist implementation of the Hong Kong 2030+ strategic study (2015) to create a liveable, smart, green, sustainable high-density city. In line with this, we will seek to:
● Encourage further multidisciplinary local and international collaborations to promote sustainability and pioneer development related to green construction, hazard prevention, energy and environment.
● Through our Departmental Advisory Board, Department Planning Committee, and industry liaison, identify key trends and address major industry concerns affecting Greater China development in areas such as smart cities and intelligent transport through a well-coordinated departmental support system, including faculty hiring and research student recruitment.
● Build up and enhance the role of our industry-university collaborative research centres, such as the new AOE Centre for Slope Safety and recent GREAT Smart Cities Institute.
● Harvest opportunities arising from high-impact government-assisted InnoHK projects, e.g. between Hong Kong, Finland and US on using AI and 5G in civil and environmental engineering.
● Administer HKUST's HK$50M **Sustainable Smart Campus as a Living Lab** (H Lo: chair), a multi-year initiative using the campus as a "live" demonstration site for research impact.

(4) Relationship to case studies

The Unit has many examples of significant impact, with our two cases reflecting how our approach enables the transfer of original research findings to society and the multiple users and beneficiaries of our work at local, national, and international levels. In the **Chen case**, our SANI paradigm-shifting technology for Hong Kong sewage management was supported in its development and testing stages by both government and industry and later transferred to HKSAR sewerage authorities, with the internationally award-winning project now benefiting the public and serving as a living example of cost-effective, eco-friendly alternative wastewater solutions. In the **Ng and Zhang case** on debris flow mitigation, collaborative research was supported by two major Hong Kong government grants as well as mainland China provincial support, bringing: novel technologies to slope management practice in densely populated areas surrounded by steep terrain and their adoption in design guides; a multi-hazard risk assessment protocol aiding engineers and road construction companies; and greater safety for millions of citizens in Hong Kong and mainland China.