Roundup: Ceiling function, the mathematical operation of rounding a number up to the next higher integer
Roundup: a term in American English referring to the process of gathering animals into an area, known as a "Muster" in Australia
Rounding up: when a helmsman cannot control a boat and it heads into the wind
Roundup: the plan for an invasion of northern France by Allied forces during World War II (Wikipedia)
*Dean's Roundup*: part blog, part bulletin; part honour roll, part curatorial [cu ra·to ri·al]

Urban ugliness

Some of my favourite architecture lies immediately north and south of the Sahara Desert. To the north, in the foothills of the High Atlas mountains of Morocco are the wildly romantic fortified mud villages. I recently acquired an ancient wooden door from a demolished building in the town of Taroudant, a place I loved to visit in my youth (near the town in this picture – I only have faded ektachromes of my orginal photos):

Source: https://www.pinterest.ch/pin/315885361347527810/
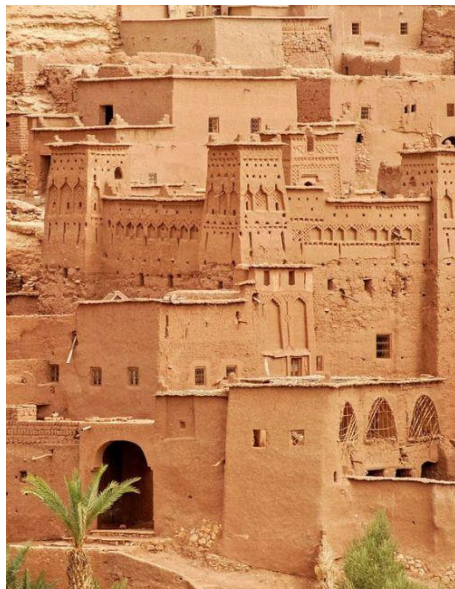
To the south of the Sahara is Burkina Faso, a country that is home to an amazing village architecture (clay, straw, cow dung mixed to a smooth mortar that hardens in a way that makes these houses look and feel like porcelain homes, with unbelievably beautiful patterned finishes in mud and chalk):
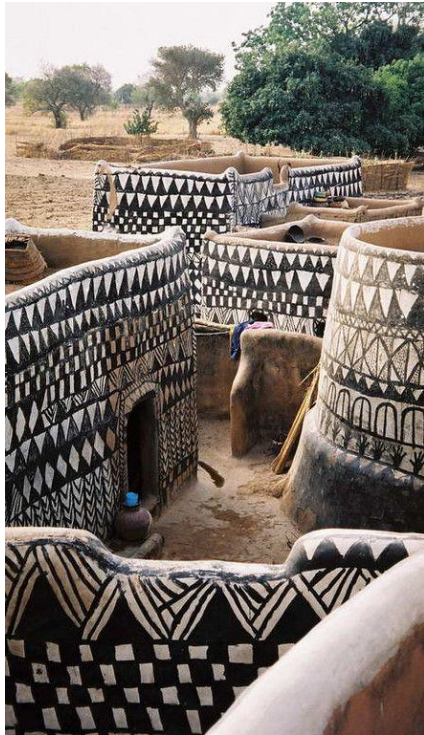
What makes so many vernacular urban spaces so beautiful and so many modern urban spaces so uncomfortable if not downright ugly? A Bloomberg blog[1] asked a similar question and I found the answer (from the perspective of a financial columnist and professor of economics) profound, simple and enlightening. To paraphrase in my own language: in the vernacular, the language and materials are homogeneous; each elemental building or part of building is individually crafted in that language; one element will harmonise with others as the craftsmen interpret, extemporise, economise and take advantage of shapes and reference points created by what is already there. Because of the common language, sentences, poems and whole stories are created, spontaneously emerging from many individual artistic and constructional decisions. The same can be said of the row houses in Britain's Victorian streets and Georgian squares and the canal-scapes of medieval Venice.

How to reproduce a similar effect in contemporary cities? Homogeneity of materials and style does not, on its own, work. I took the following picture in 2006 as Guangzhou's 'University Island' was being constructed. Alongside the university campus buildings and remaining *chengzhongcun* migrant villages, the plan included an upmarket shopping street designed in a faux Chinese historical style. As you can see, it is not unappealing. But if it creates a poem at all, it is a cliched and reproduction poem. The lively, narrow and disorganised alleyways of the adjacent chengzhongcun, struck me as creating a much more beautiful and authentic story.

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[1] Tyler Cohen, Bloomberg.com, 5 October 2021, https://www.bloomberg.com/opinion/articles/2021-10-05/urban-design-why-can-t-we-build-nice-neighborhoods-anymore

Clearly the missing ingredient is individual craft, with individual craftsmen and craftswomen working separately but over time, together, on different elements. This is not scalable as a modern building technology. But what if robots could be used to both design and build component elements of a house, or of a collection of houses or street or square, each mimicking the hands and minds and imperfections and rhythms of old-time craft workers?

Could robotic architecture scale up the unscalable, lead us back to the future, reverse us out of the culdesacs of modernist, postmodernist and mass-produced style, and eventually free us from urban ugliness?

Who will write the code?

Congratulations to colleagues mentioned below for their achivements.

Chris
Dean, FoA

Faculty of Architecture

1. Welcome to Dr Liu Sheng, Dr Wu Shengbiao and Dr Yang Yiyang, who joined us as Post-doctoral Fellows with the Division of Landscape Architecture in October 2021.

| Dr Liu Sheng | Dr Wu Shengbiao | Dr Yang Yiyang |

2. Future of Cities – new launch on World Cities Day on 31 October 2021

- comprises 12 thought-provoking short films, each focusing on a theme that is practically significant, theoretically rich and existentially important to the future of civilisation, while linked to research currently or recently undertaken in FoA's HKUrbanLabs. Featured topics include the urban/rural divide, informal spaces in cities, aging urban populations, pandemic resilience, smart-city technologies, urban system optimisation, urban greening and farming, urban externalities, social inequality, city boundaries, and settlement patterns of the future. The film series has recently been covered by:
  - DesignBoom
  - Places Wire
  - India Education Diary

More about the Future of Cities:
https://www.arch.hku.hk/research/the-future-of-cities/
https://www.hku.hk/press/news_detail_23468.html

Department of Architecture

1. DFA CreateSmart Young Design Talent Special Award 2021

- Alumna Nesia Cheung (BAAS 2018; MArch 2021) has won in this year's DFA Hong Kong Young Design Talent Award (Environmental Design), with her thesis 'Dis-a-pier | Re-a-pier', advised by Dr Tao Zhu and Guillaume Othenin-Girard, along with Professor Nasrine Seraji.

    The thesis project proposes to turn the dismantled Queen's Pier into a constant process of re-appearing, to retell and re-make history, and to raise awareness of Hong Kong's disappearing historical buildings.

    Established in 2005, DFA Hong Kong Young Design Talent Award aims to nurture up-and-coming design practitioners and graduates aged 18-35, by providing the awardees with financial sponsorship to work in overseas design companies for 6 to 12 months or study abroad for 6 to 18 months.

    More information:
    https://www.arch.hku.hk/nesia-cheung/
    https://ydta.dfaawards.com/en/winner_detail/?w=1&id=kMsEokhGRFA

2. HKU Architecture Gallery @ Knowles – 3/F Corridor Exhibitions

(i)   Housing Enquiries

Housing is not a room, not a house, not a public house.
Housing is everything.
Housing is plural, not individual, yet intimate.
Housing is difficult but unapologetic.
Housing is the backbone of all cities.
Housing is global, but at the same time very local.
Housing is true urban without the 'ism'.
Housing is sometimes failure but also success.
Housing is not only social, it transcends it.
Housing is not stereotypical.
Housing is a testimony of time.
Housing is not just about highs and lows.
Housing is experimental while educational.
Housing is learning how to juggle with scales.
Housing is multifunctional and physically hierarchical.
Housing is relative thinking.
Housing is many thresholds from public to private.
Housing is a synthesis of differences, not a segregation.
Housing is not for everyone.
Housing is fundamentally architectural.

Housing is Year 4

This exhibition presents a collection of drawings made by BA(AS) Year 4 students, selected from a three-week period of precedents' analysis.

The next phase will take these precedents as physical sites and upgrade them with a minimum of 30% of living programme as a means to create a critical dialogue between the old and the new.

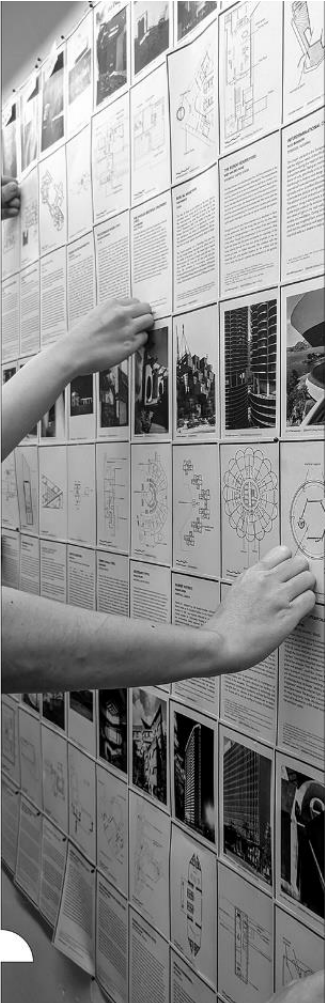**Teaching Team:** Roberto Requejo Belette, Holger Kehne, Anderson Lee, Olivier Ottevaere, and Human Wu

Date:	**11 October (Monday) - 15 November 2021 (Monday)**
Venue:	**3/F Corridor, Knowles Building (alongside KB319)**

(ii)   Modern Architecture: Postcards

The repertoire of modern architecture is expanding. Modern architecture's aesthetic and technological project has overshadowed the other 'projects', primarily the social and the climatic. This inventory of postcards on modern architecture, collectively produced by students each describing three examples of architectural modernism through a photograph, a plan, and a piece of written text, presents the building subject as part of a simultaneously coherent yet discursive history of ideas, identities, images, places, and technologies. The postcards characterise modern architecture not only as a style or movement but a complex and contradictory history bound by key formal, theoretical, social, cultural, technological, economic, and political moments in time.

This exhibition constitutes the Assignment 1 of the course ARCH2058 History and Theory of Modern Architecture taught by Dr Eunice Seng, with support from Sereypagna Pen, Putri R. Santoso, and Wan Yan.

Exhibition Team (Students): Chen Yushan, Chiu Yeuk Tung, Chung Wing Sze Cecilia, Gong Tianshu, Ludwig A. E. Hochleitner, Hon Ming Rou, Jiao Yian, Kim Daegeun, Jennifer Lam, Sammie Ng, Sereypagna Pen, Ivan Ardian Santoso, Putri R. Santoso, Sun Ziyue, Fergal Tse Yau Wai, Wan Yan, Yau Pui Yu, Indrawan Valdy, Wang Qianhui, Zhang Yifan

Date: **7 October (Thursday) - 15 November 2021 (Monday)**

Venue: **3/F Corridor, Knowles Building (alongside KB315)**

Division of Landcape Architecture

1. Shing-chun Chu (MLA 2020), supervised by Dr Xiaoxuan Lu

    - has received the Award of Excellence, in the category of Analysis and Planning, at the [American Society of Landscape Architects (ASLA) 2021 Student Awards](#), for his project [Paddock Rewilding: an Agri-wilding Scenario for a Regenerative Rural Heritage Landscape in Post-productivist Cambrian Mountains, Wales](#).

       The 35 winners of this year were chosen from 440 submissions of projects from around the world, by a jury panel representing a broad cross-section of the professions, from the public and private sectors to the academia. Award categories include: General Design, Urban Design, Residential Design, Analysis and Planning, Communications, Research, Student Collaboration, and Community Service.

       Together with other awardees, Shing-chun will be honored at the ASLA 2021 Conference on Landscape Architecture, scheduled to take place in Nashville, Tennessee, USA, on 20 November 2021.

Analysis and Planning Category

Award of Excellence

Paddock Rewilding: An Agri-wilding Scenario for a Regenerative Rural Heritage Landscape in Post-productivist Cambrian Mountains, Wales
Cambrian Mountains, United Kingdom
Shing Chun Chu
Faculty Advisors: Xiaoxuan Lu, ASLA
University of Hong Kong

Does an antidote to our landscape exist to mend the impairment that was orchestrated by us? Under all the challenges of extreme weather, mass extinctions, severe pollutions - Global authorities are pulling out all the stops, desparately, to hopefully evade the ghastly future.

Rewilding, a novel eco-centric approach that is promoted across disciplines - to introduce pristine wilderness back into humanity and allow open-ended natural processes to regain dominance with minimal human control, this approach flourishes as a result of marginal farmland abandonment across Europe, has meanwhile sparked debate with farmers who live off the culture-saturated land that historically embraces active management, the predicament between production and environment is never resolved.

2. Vincci Mak (Principal Investigator), Dr Gary Wong (Co-Investigator, HKU Sociology) and Michelle Chan (External Partner, Visual Artist)

   - have been awarded by the HKU Knowledge Exchange (KE) Funding Exercise 2021/22 – Impact Project Scheme, for the amount of HK$150,000, for their proposal titled 'Art Engagement in Documenting the Disappearing Wah Fu Estate'.

     Project Summary: *Wah Fu Estate's Redevelopment has just been launched earlier this year (2021), and many of the spaces that constitute to the everyday life of its residents are rapidly disappearing. This project proposes to use art engagement in photography to encourage Wah Fu Estate residents to actively participate in the documentation of these everyday life routines and spaces. It aims to support the existing identity building of the community, and to help transition and sustain such bonding in the future redeveloped Wah Fu Estate.*
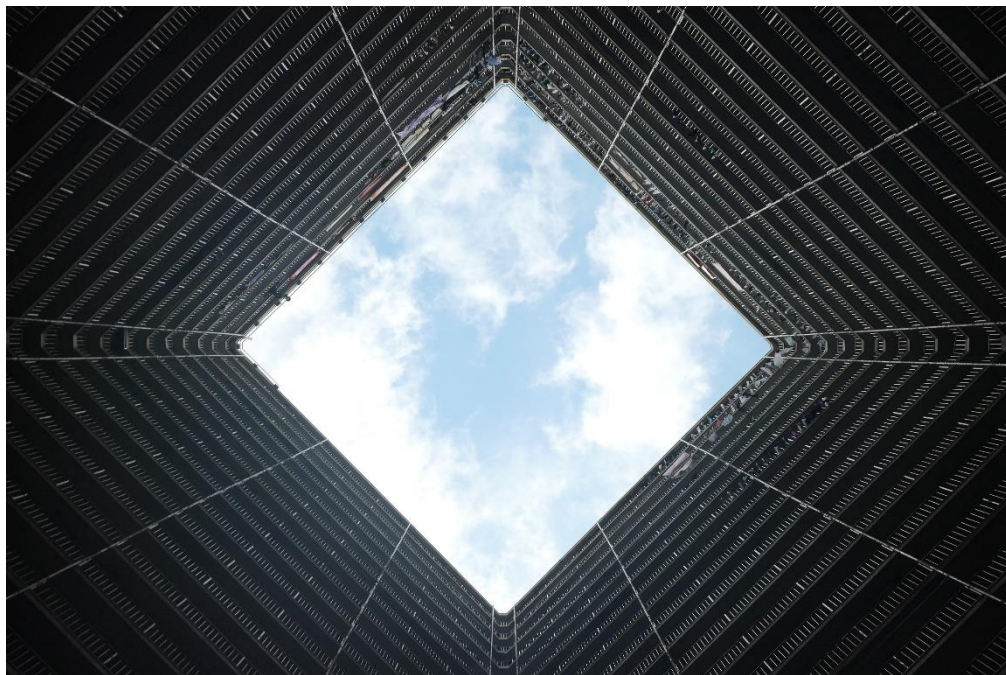
3. Nikolas Ettel

   - has been featured in the following South China Morning Post article on 5 November 2021:

     'The forgotten architectural features that dot Hong Kong's streets, and why such phenomena are called Thomassons after an ex-New York Yankees baseball player'

     https://www.scmp.com/lifestyle/arts-culture/article/3154419/forgotten-architectural-features-dot-hong-kongs-streets-and

LIFE

DESIGN

A GUIDE TO ODD STRUCTURES THAT SERVE NO PURPOSE

The city's streets are filled with 'Thomassons' – utterly useless but well-maintained architectural leftovers – which are the subject of a TEDx talk

Stephen McCarty

> We found interesting things that go way beyond any narrow scope

A staircase to nowhere in Sheung Wan qualifies as a Thomasson. Photo: Hu Jiapeng and a1 architecture

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- has also examined the city's 'Thomassons' such as architectural leftovers in the TEDxHKU talk on 6 November 2021.

11

Department of Real Estate and Construction

1. Professor Lawrence Lai

   - was featured in this article on Ta Kung Pao, 2 November 2021, where he shared his view on conserving the war relics in Luk Keng:

     消失的歷史 2 / 奔波鹿頸山 10 年 保育 14 座二戰槍堡

Department of Urban Planning and Design

1. Alain Chiaradia

   - was invited to serve in the Jury Panel for the Hong Kong Institute of Urban Design (HKIUD) Urban Design Awards 2021 (Built, Plan/Concept).

     More information: https://www.hkiud.org/awards/2021/2021awards.php

   - has received an honourable mention at the Jin Jing Chang Urban Planning Best Papers 2021, which celebrated leading research across the Chinese planning community, for the following co-authored publication:

     Zhang, L., **Chiaradia, A.**, **Cui, M.**, & **Zeng, W.** (2020). The elders' preferences for open spaces in a multi-level, hyper-dense sub-tropical city (in Chinese), *Urban Planning International*, *35*(1), 36-46. https://dx.doi.org/10.19830/j.upi.2019.672

     Abstract: An opinion survey in Hong Kong shows that small playgrounds and sitting-out areas' visitation frequency increases by age groups from 16-29 to 60-70+. Size, accessibility, quality, and facilities of small public spaces have an impact on elderly's visitation preferences. This paper compares the spatial distribution of accessibility and potential flow, size, quality and use of small open spaces (n=50) in Wan Chai and Sha Tin. Using mixed methods including network science, unsupervised machine classification, 3D full indoor + outdoor pedestrian network map, surveys and pedestrian route choice simulations, it is revealed that both size and accessibility have a strong impact on small open spaces' design quality and elderly visitation. The exploration of elderly open space qualities and elderly preferences in high-density cities in sub-tropical climate, provides research and policy directions for the future age-friendly urban open space planning system in Mainland China.

     The ceremony took place on 30 October 2021 as part of the 18th China Urban Planning Discipline Development Forum: https://www.163.com/dy/article/GNQQN95H0516C1LE.html

2. Professor Shenjing He

   - has been conferred the Award of the Fellowship of the Academy of Social Sciences (FAcSS) for the excellence of her research work and outstanding contribution to social science. This honour is recognised as the highest accolade in the social sciences field. For more information, please refer to https://acss.org.uk/our-fellows/.

- was elected to be the Chair of Country Park Board, Country and Marine Parks Board, Agriculture, Fisheries and Conservation Department, The Government of the Hong Kong SAR, for a term of two years from 2021 to 2023.

- has accepted the invitation from HKU Department of Geography for the conferment of the title of Professor (by courtesy), for a period of three years from 1 January 2022 onwards.

- was invited to join the Adjudication Panel for the Hong Kong Institute of Planners (HKIP) Awards 2021. The Panel meeting was held at the City Gallery on 6 November 2021.


3. DUPAD/CUSUP 40th Anniversary Event Series

- has been launched in celebration of the establishment of the Centre of Urban Studies and Urban Planning (CUSUP) in 1980 and its subsequent development to become the Department of Urban Planning and Design (DUPAD) at the University of Hong Kong. The distinguished webinar series in Urban and Regional Research is sponsored jointly by the Department of Urban Planning and Design and Department of Geography, HKU.

(i). Professor John Logan from the Department of Sociology, Brown University, delivered the first webinar in this series via Zoom on 21 October 2021 (Thursday).

The presentation topic was 'The Impact of Suburbanization on Racial Segregation at a Metropolitan Scale, 1940-1970'. More than 200 participants joined the webinar.
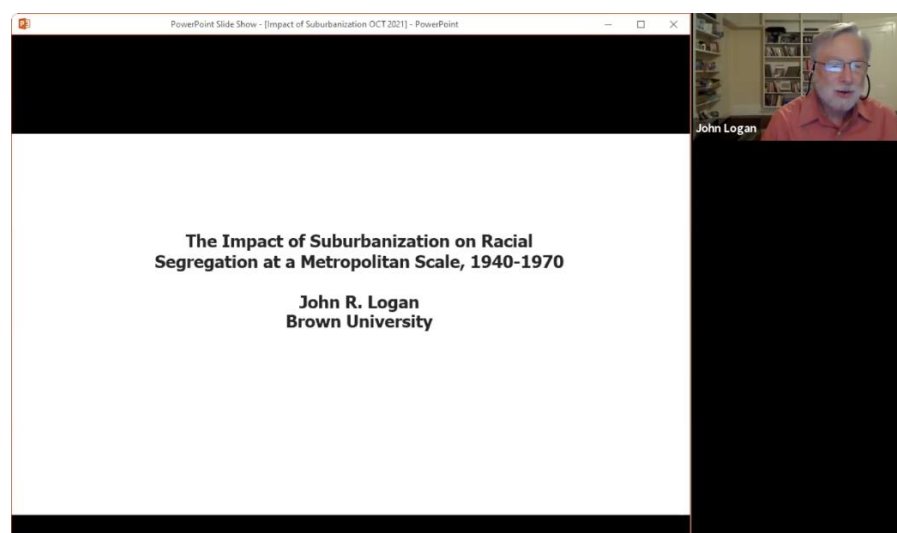

(ii). Professor Fulong Wu, Bartlett Professor of Planning from the University College London delivered the second webinar in this series via Zoom on 5 November 2021 (Friday).

The presentation topic was 'Beyond Growth Machine Dynamics: Rethinking State Politics in China's Urban Redevelopment'. More than 300 participants joined the webinar.
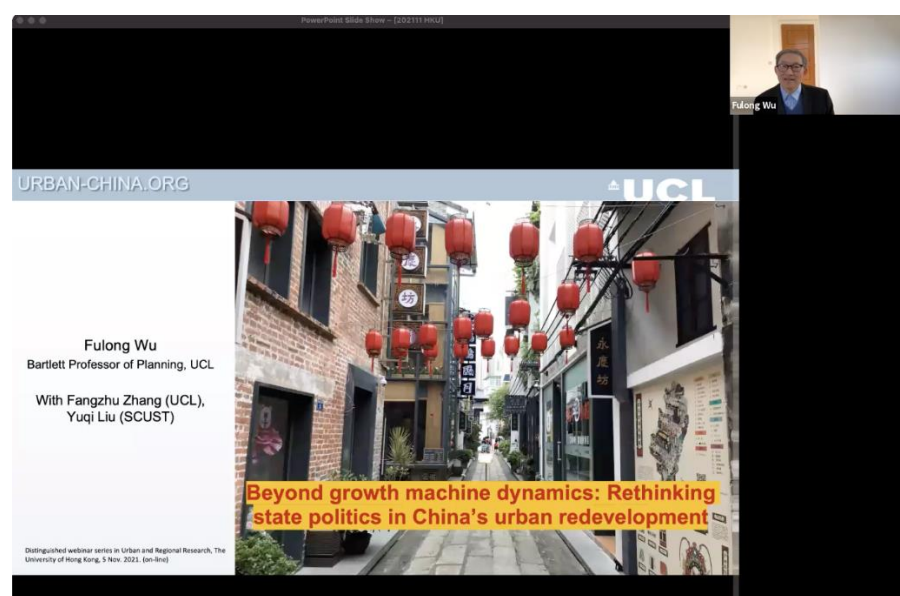
(iii). An alumni sharing session presented by Professor K. K. Ling, Strategic Planning Advisor for Hong Kong/Shenzhen Cooperation was delivered virtually via Zoom on 9 November 2021 (Tuesday). Professor Ling graduated from HKU's Master of Science in Urban Planning Programme in 1983.

The presenation topic was 'Northern Metropolis Development Strategy -- Concepts and Drives'. More than 100 participants joined the sharing session.
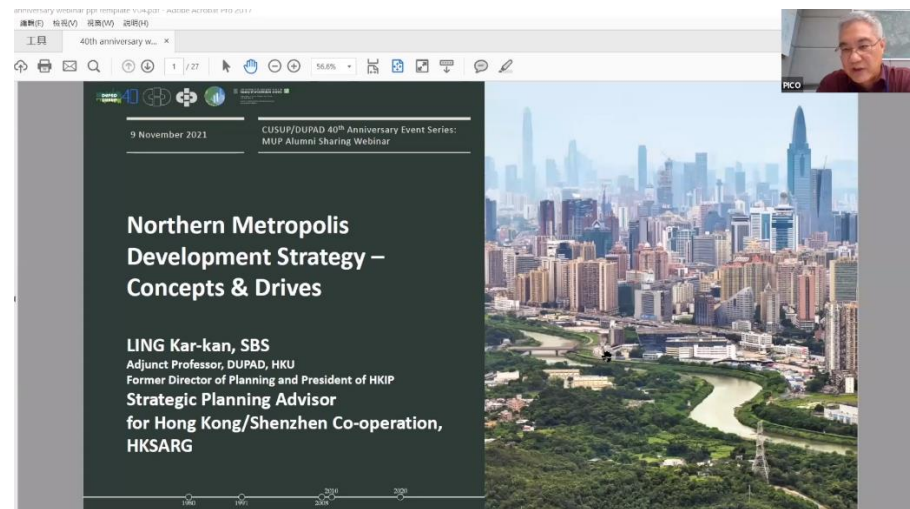
Centre of Urban Studies and Urban Planning

1. Alain Chiaradia

   - was invited to the round table discussion 'Market Opportunities for Evidence-based Practices' of the Knowledge Alliance for Evidence Based Urban Practice (KAEBUP), a research project to build a bridge from research to practice co-funded by the Erasmus Programme of the European Union, on 7 October 2021.

     https://www.facebook.com/events/288736812831477/?ref=newsfeed
     https://www.facebook.com/kaebup/photos/pcb.233236405513761/233236245513777/

   - was invited to serve on the Design Theory Committee of DC I/O 2021 – Design Computation Conference in London, on 6-10 October 2021.

     https://www.designcomputation.org/dcio-about
   https://www.designcomputation.org/2021-committee

2. Professor Shenjing He

   - was invited to present a paper entitled 'The Rise of Education-featured Gated Communities and Urban (Re)development in Urban China', at the Tianjin Forum (in hybrid mode), on 16 October 2021.

     Sponsored by the CHEY Institute for Advanced Studies based in South Korea and in a close partnership with Nankai University, Tianjin Forum was launched in 2015 and now becomes a significant international forum for urbanisation and urban development. This year's theme is 'Constructing High-quality Urban Space'.
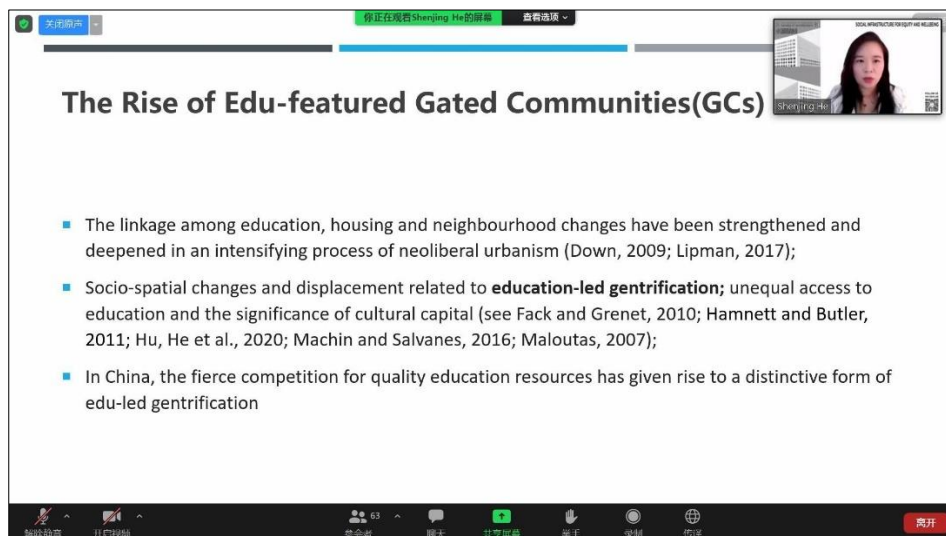
-   was invited to give a plenary speech entitled 'The Rise of Education-featured Gated Communities in Chinese Cities: (Re)producing the enterprising self via the entrepreneurial local state-capital nexus', at the Annual Conference of Urban Geography in China, hosted by East China Normal University and the Chinese Geographical Society, on 25 September 2021. This conference was attended by over 300 participants online and in person.
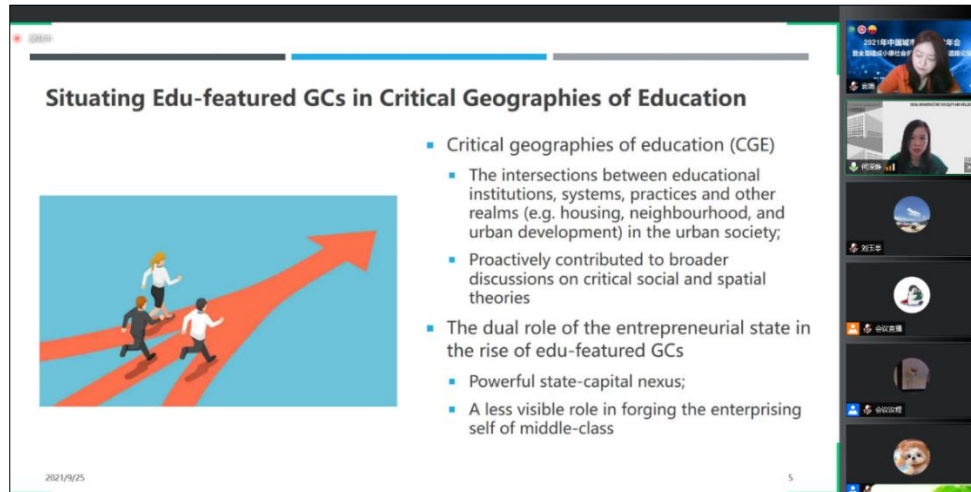
-   was invited to give an online talk with her PhD student Xiang Yan on 3 November 2021, entitled 'Examining the multi-dimensional and multiscalar healthcare inequalities in urban China: Towards a synthesized approach', sponsored by the Harvard Fairbank Center for Chinese Studies & MIT Sustainable Urbanization Lab.

-   published a book (co-authored with Zhigang Li and Yuting Liu) entitled *Urban Social Space in China*, as part of the *Urban Geography in China* book series published by Science Press.

3. Dr Derrick Ho

- has published the following paper:

Lai, E. T. C., **Ho, H. C.**, Ho, S. C., & Woo, J. (in press). Socioeconomic status, physical functioning and mortality: Results from a cohort study of older adults in Hong Kong. *Journal of the American Medical Directors Association*, ISSN 1525-8610. https://doi.org/10.1016/j.jamda.2021.08.034

Objectives: *It is inconsistent in the literature on whether inequalities of health in older age widen or narrow over time. We assessed the associations of socioeconomic status (SES), physical functioning, and mortality in an older age cohort in Hong Kong.*
Design: Longitudinal cohort study.

Setting and Participants: We recruited 2032 older adults aged 70+ in 1991 to 1992 and followed them for 10 years.

Methods: *SES was operationalized as education, baseline individual income, and longest-held occupation in lifetime. Physical functioning was measured by Barthel's Index for activities of daily living (ADL), from which disability was defined as ADL score <20. Mortality data were obtained from the Death Registry. Bayesian joint modeling with 2 sub-models, mixed-effect, and Cox proportional hazard model, were used to respectively model the associations of SES and disability, and SES and mortality, accounting for selection by mortality.*

Results: *Education and income at baseline were not clearly related to disability, but those with lower education level and income at baseline tended to have their risks increased with time. Older adults who had been mostly economically inactive or unemployed in their lifetime had higher risk of disability [odds ratio 3.24; 95% credible interval (95%CrI) 1.29 to 7.97], and such risk increased over time. For mortality, older adults with no schooling were at higher risk compared with those with secondary education or above (hazard ratio 1.25; 95%CrI 1.00 to 1.57). Income at baseline and longest-held occupation in lifetime were not clearly related to mortality.*

Conclusions and Implications: *We observed inequalities of health of older adults in Hong Kong that widened as they age. Community and medical interventions targeting the older adults with the lowest SES would be important to prevent their more rapid decline in physical functioning.*

4. Dr Zhao Zhan

    -   has published the following paper:

    * corresponding author

    Abstract*: Individual mobility is driven by demand for activities with diverse spatiotemporal patterns, but existing methods for mobility prediction often overlook the underlying activity patterns. Knowledge of activity patterns can improve the performance and interpretability of existing individual mobility models, leading to more informed policy design and better user experience in intelligent transportation systems. This study develops an activity-based modeling framework for individual mobility prediction in mass transit systems. Specifically, an input-output hidden Markov model (IOHMM) approach is proposed to simultaneously predict the (continuous) time and (discrete) location of an individual's next trip using transit smart card data. The prediction task can be transformed into predicting the hidden activity duration and end location. Based on a case study of Hong Kong's metro system, we show that the proposed model can achieve similar prediction performance as the state-of-the-art long short-term memory (LSTM) model. Unlike LSTM, the proposed IOHMM approach can also be used to analyze hidden activity patterns, which provides meaningful behavioral interpretation for why an individual makes a certain trip. Therefore, the activity-based prediction framework offers a way to preserve the predictive power of advanced machine learning methods while enhancing our ability to generate insightful behavioral explanations, which is useful for user-centric policy design and intelligent transportation applications such as personalized traveler information.*

5. Dr Yulun Zhou

-   has published the following paper.

Bongiorno, C., **Zhou, Y.**, Kryven, M., Theurel, D., Rizzo, A., Santi, P., Tenenbaum, J., & Ratti, C. (2021). Vector-based pedestrian navigation in cities. *Nature Computational Science, 1*(10), 678-685, ISSN 2662-8457. https://doi.org/10.1038/s43588-021-00130-y

Abstract: *How do pedestrians choose their paths within city street networks? Researchers have tried to shed light on this matter through strictly controlled experiments, but an ultimate answer based on real-world mobility data is still lacking. Here, we analyze salient features of human path planning through a statistical analysis of a massive dataset of GPS traces, which reveals that (1) people increasingly deviate from the shortest path when the distance between origin and destination increases and (2) chosen paths are statistically different when origin and destination are swapped. We posit that direction to goal is a main driver of path planning and develop a vector-based navigation model; the resulting trajectories, which we have termed pointiest paths, are a statistically better predictor of human paths than a model based on minimizing distance with stochastic effects. Our findings generalize across two major US cities with different street networks, hinting to the fact that vector-based navigation might be a universal property of human path planning.*

Nature Altmetric Score: Top 1% of All Research Outputs
https://nature.altmetric.com/details/115394764#score
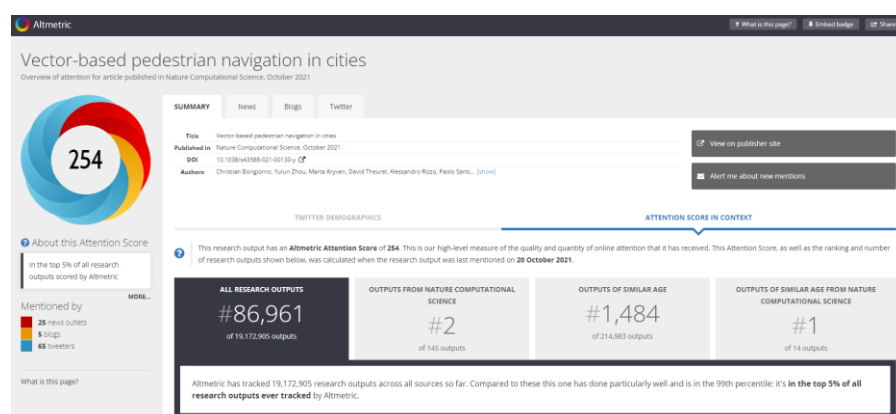
Media Coverage: *20+ International media including MIT News, Yahoo and Phys.org.*

In this research, not only did the team investigate how human brains navigate complex urban street networks against the deterministic and symmetric machine approach, but they also demonstrated urban big data's huge potential in driving advancements in computational and cognitive sciences.

6. Professor Anthony Yeh

- has published the following paper with PhD students Guan Huang and Si Qiao:

Abstract*: The capability of ridesplitting service to address current urban transportation problems has attracted considerable research interest in recent years. Given that ridesplitting needs an adequate user base to realize "sharing", its success highly depends on a comprehensive understanding of people's willingness of using it. However, previous studies mainly focused on the ridesplitting willingness based on questionnaire surveys at the individual level, which may help transportation network companies find potential users, but lacked studies on people's ridesplitting willingness from the perspective of the built environment and time-space integration, because the macro urban elements are difficult to be perceived by individuals and thus hard to reflect in questionnaires. Thus, this study estimates the ridesplitting willingness rate of different areas in a city at different times of the day by building a model on the shared order rate and shareability from the real-world DiDi Chuxing dataset, using Chengdu, China, as a case study. The spatial lag model (SLM) is further utilized to exam the relationship between the willingness rate, built environment and transportation-related variables. Results revealed the ridesplitting willingness rate has a significant spatiotemporal pattern between the urban centre and urban periphery and can be divided into morning peak, noon plateau, afternoon valley, night peak, and midnight valley. SLM models indicate that the ridesplitting willingness rate has a significant spatial dependency on its vicinity areas at the origin of the daytime periods or at the destination at night. The distance to urban centre, the distance to railway station, travel demand, accessibility to public transit, land use mixture, and the trip purpose are found to be the most relevant variables with the willingness rate, while the points of interest (POIs) are almost irrelevant. The findings of this study can be helpful to the future promotion of this sustainable service and formulation of policy to improve service quality.*
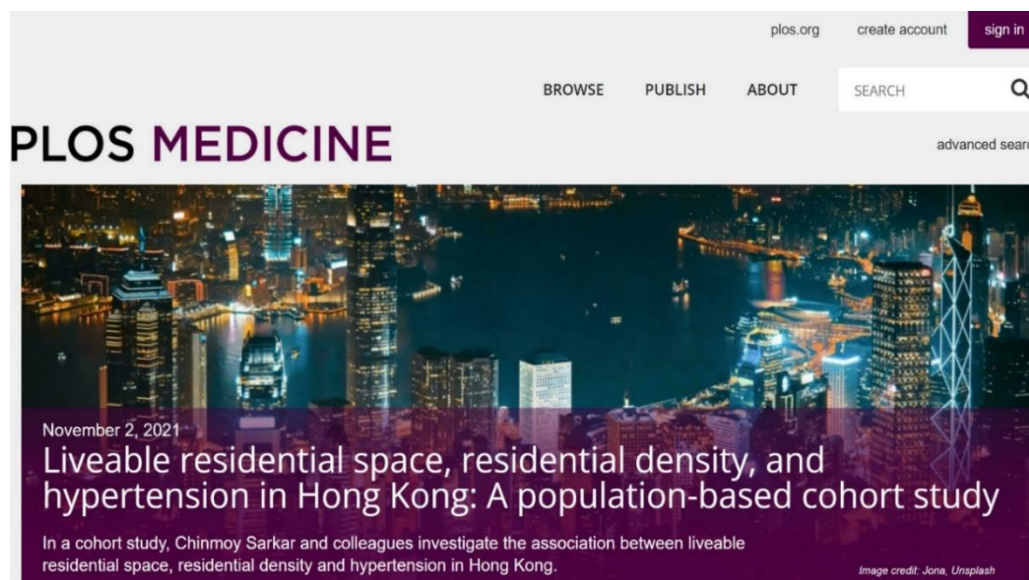
Healthy High Density Cities Lab

1. Dr Chinmoy Sarkar, Ka Yan Yvonne Lai, Sarika Kumari, Dean Webster

   - have their co-authored paper in collaboration with Dean Gabriel Leung and Dr Michael Ni of School of Public Health, LKS Faculty of Medicine published in *PLOS Medicine*:

   Sarkar, C.‡*, Lai, K. Y.‡, Ni, Michael Y., Kumari, S., Leung, G. M., & Webster, C. (2021). Liveable residential space, residential density, and hypertension in Hong Kong: A population-based cohort study. *PLOS Medicine, 18*(11), e1003824. https://doi.org/10.1371/journal.pmed.1003824 [IF: 11.069, Ranking: 10/169, Q1 in Medicine, General & Internal]

   corresponding author, ‡ joint first-author (equal contribution)

PLOS MEDICINE

November 2, 2021
Liveable residential space, residential density, and hypertension in Hong Kong: A population-based cohort study

In a cohort study, Chinmoy Sarkar and colleagues investigate the association between liveable residential space, residential density and hypertension in Hong Kong.

Image credit: Jona, Unsplash

Background
Hypertension is a leading preventable risk factor of chronic disease and all-cause mortality. Housing is a fundamental social determinant of health. Yet, little is known about the impacts of liveable residential space and density on hypertension.

Methods and findings
This retrospective observational study (median follow-up of 2.2 years) leveraged the FAMILY Cohort, a large territory-wide cohort in Hong Kong, Special Administrative Region, People's Republic of China to quantify associations of objectively measured liveable space and residential density with blood pressure outcomes among adults aged ≥16 years. Blood pressure outcomes comprised diastolic blood pressure (DBP), systolic blood pressure (SBP), mean arterial pressure (MAP), and hypertension. Liveable space was measured as residential floor area, and density was assessed using the number of residential units per

building block and residential unit density within predefined neighborhood catchments. Multivariable regression models examined associations of liveable floor area and residential density with prevalent and incident hypertension. We investigated effect modifications by age, sex, income, employment status, and housing type. Propensity score matching was further employed to match a subset of participants who moved to smaller residences at follow-up with equivalent controls who did not move, and generalized linear models examined the impact of moving to smaller residences upon blood pressure outcomes. Our fully adjusted models of prevalent hypertension outcomes comprised 30,439 participants at baseline, while 13,895 participants were available for incident models at follow-up. We found that each interquartile range (IQR) increment in liveable floor area was associated with lower DBP (beta [β] = −0.269 mm Hg, 95% confidence interval [CI]: −0.419 to −0.118, p <0.001), SBP (β = −0.317 mm Hg, −0.551 to −0.084, p = 0.008), MAP (β = −0.285 mm Hg, −0.451 to −0.119 with p < 0.001), and prevalent hypertension (odds ratio [OR] = 0.955, 0.918 to 0.993, p = 0.022) at baseline. Each IQR increment in residential units per building block was associated with higher DBP (β = 0.477 mm Hg, 0.212 to 0.742, p = <0.001), SBP (β = 0.750 mm Hg, 0.322 to 1.177, p = <0.001), MAP (β = 0.568 mm Hg, 0.269 to 0.866, p <0.001), and prevalent hypertension (OR = 1.091, 1.024 to 1.162, p = 0.007). Each IQR increase in neighborhood residential density within 0.5-mi street catchment was associated with lower DBP (β = −0.289 mm Hg, −0.441 to −0.137, p = <0.001), SBP (β = −0.411 mm Hg, −0.655 to −0.168, p < 0.001), MAP (β = −0.330 mm Hg, −0.501 to −0.159, p = <0.001), and lower prevalent hypertension (OR = 0.933, 0.899 to 0.969, p < 0.001). In the longitudinal analyses, each IQR increment in liveable floor area was associated with lower DBP (β = −0.237 mm Hg, −0.431 to −0.043, p = 0.016), MAP (β = −0.244 mm Hg, −0.444 to −0.043, p = 0.017), and incident hypertension (adjusted OR = 0.909, 0.836 to 0.988, p = 0.025). The inverse associations between larger liveable area and blood pressure outcomes were more pronounced among women and those residing in public housing. In the propensity-matched analysis, participants moving to residences of lower liveable floor area were associated with higher odds of incident hypertension in reference to those who did not move (OR = 1.623, 1.173 to 2.199, p = 0.002). The major limitations of the study are unmeasured residual confounding and loss to follow-up.

Conclusions
We disentangled the association of micro-, meso-, and macrolevel residential densities with hypertension and found that higher liveable floor area and neighborhood scale residential density were associated with lower odds of hypertension. These findings suggest adequate housing in the form of provisioning of sufficient liveable space and optimizing residential density at the building block, and neighborhood levels should be investigated as a potential population-wide preventive strategy for lowering hypertension and associated chronic diseases.

Author summary

Why was this study done?
- Hypertension is the leading preventable risk factor of cardiovascular disease (CVD) and all-cause mortality.
- The fundamental role of housing in shaping population health has been acknowledged by the World Health Organization (WHO) and the American Heart Association.
- However, scientific evidence with regard to the relationship of housing overcrowding and density with hypertension has been insufficient.

What did the researchers do and find?
- We examined associations of objectively measured liveable space and multiscalar residential density with hypertension among adults employing 2 consecutive waves of a large territory-wide cohort in Hong Kong, Special Administrative Region, People'sRepublic of China.
- At baseline, each interquartile range (IQR) increment in liveable floor area was associated with lower blood pressure and prevalent hypertension. At the block level, each IQR increase in residential units per building block was associated with higher blood pressure and prevalent hypertension. At a neighborhood level, higher residential density was associated with lower blood pressure and hypertension.
- Our longitudinal analysis found that each IQR increment in liveable floor area was associated with 9.1% lower odds of incident hypertension.
- Propensity-matched analysis found that in reference to participants who did not move, those relocating to residences of lower liveable floor area was associated with higher odds of hypertension.

What do these findings mean?
- Provisioning adequate liveable space and optimizing density of residential units at building block and neighborhood levels may act as population-wide preventive strategies for lowering the burden of hypertension.
- The evidence can inform housing policy toward health-centric housing space allocation and densification while planning, designing, and retrofitting high-density cities of similar contexts.

- have their co-authored paper in collaboration with Dean Gabriel Leung and Dr Michael Ni of School of Public Health, LKS Faculty of Medicine published in *JAMA Network Open*:

Sarkar, C.‡*, Lai K. Y.‡, Kumari, S., Leung, G. M., Webster, C., Ni, M. Y. (2021). Characteristics of the residential environment and their association with depression in Hong Kong. *JAMA Network Open, 4*(10), e2130777. https://doi.org/10.1001/jamanetworkopen.2021.30777 [IF: 8.483, Ranking: 15/169, Q1 in Medicine, General & Internal]

Importance*: With rapid urbanization, understanding the role of residential environments in the development of depression has gained importance. However, the potential associations of residential space and density with depression have been understudied.*

Objective*: To investigate longitudinal associations of residential liveable space and density with depression.*

Design, Setting, and Participants*: This longitudinal cohort study used data from 2 waves of the FAMILY Cohort, a population-based cohort in the Hong Kong Special Administrative Region, China, recruited between February 28, 2009, and March 28, 2011, at baseline and followed up between August 03, 2011, and June 19, 2013, at wave 2. Data 2 were analyzed from September 1, 2020, through August 10, 2021. A total of 16 968 participants aged 16 years or older underwent assessment using the Patient Health Questionnaire-9 (PHQ-9) and had complete data across all variables.*

Exposures*: Residential density was objectively assessed at 3 scales (within apartment, building block, and at neighborhood-level) at baseline and follow-up.*

Main Outcomes and Measures*: Depressive symptoms were defined in terms of a PHQ-9 threshold greater than or equal to 5 and probable major depression with a cut-off value greater than or equal to 10. A continuous PHQ-9 score was used as a secondary outcome. Multilevel logistic regression models were used to examine associations of the residential environment with probable major depression and depressive symptoms adjusted for time-varying socio-demographic and lifestyle factors, comorbidities, and other environment variables.*

Results*: Of the 16 968 participants with complete data, at baseline, the mean (SD) age was 45.5 (16.7) years, and 9328 participants (55.0%) were women. The mean follow-up was 2.2 years (range, 1.3-3.6 years). At the household level, after full adjustments, each IQR increment in residential liveable area was associated with lower odds of 7 probable major depression (adjusted odds ratio [aOR], 0.84; 95% CI, 0.71- 8 0.98; P = .03) and depressive symptoms (aOR, 0.93; 95% CI, 0.86-1.00; P = .04). At the building block level, each IQR increment in block density was associated with higher odds of depressive symptoms (aOR, 1.11; 95% CI, 1.01-1.22; P = .03), but only in our single housing environment*

models. The results remained consistent in continuous models with PHQ-9 evaluation.

Conclusions and Relevance*: This study's findings suggest that residential liveable space and block density may play a role in the development of depression. Integrated mental health and housing policies promoting mental capital of cities, such as health-optimized density at the household and building-block levels, might serve as a population approach to reduce the burden of depression.*

Key Points*:*

Question: *Are residential environments, specifically liveable space and residential density at a building- block-, and neighborhood -level, associated with depression?*

Findings*: In this cohort study involving 16 968 participants followed -up over two 2 waves, each IQR increment in livable area was associated with 16% lower odds of probable major depression and 7% lower odds of depressive symptoms. Each IQR increment in building-block density was associated with 11% higher odds of depressive symptoms, only in single housing environment models.*

Meaning*: These findings suggest that policies to provide more residential livable space and lower residential density at the building-block scale may be associated with less depression.*

2. Ka Yan Yvonne Lai, Sarika Kumari, Professor John Gallacher, Dean Webster, Dr Chinmoy Sarkar

- have their paper accepted for publication in *Environment International*:

   Lai, K. Y., **Kumari**, **S.**, Gallacher, J., **Webster, C.**, & **Sarkar, C.*** (2022). Associations of residential walkability and greenness with arterial stiffness in the UK Biobank. *Environment International, 158*, 106960. https://doi.org/10.1016/j.envint.2021.106960 [IF:9.621 Ranking: 14/274, Q1 in Environmental Sciences]

   Background: *Arterial stiffness is a key non-invasive marker of early vascular ageing, however, little is known of its associations with urban built environment. We examined the associations of objectively-measured residential walkability and greenness with arterial stiffness in a large UK-wide population cohort.*

   Methods: *We employed data from the baseline UK Biobank cohort comprising adult participants recruited over the period of 2006 to 2010. Residential walkability index, defined as a function of density (residential, retail and public transit), street-level design, and destination accessibility was measured using a 1-Km dwelling catchment, while greenness was*

modelled as the mean <u>Normalized Difference Vegetation Index</u> (NDVI) of 0.5-metre resolution assessed within a 0.5-Km catchment. Arterial stiffness index (ASI) was measured non-invasively from the pulse waveform. Linear regression models were developed to examine associations of walkability and greenness with arterial stiffness. Restricted cubic spline (RCS) models were developed to examine dose–response relationships. We also examined effect modifications by sex and age, as well as the interaction effect of greenness and walkability.

Results: This cross-sectional study used a target sample of 169,704 UK Biobank participants aged ≥ 39 years. After full adjustments, in reference to the lowest walkability exposure <u>quartile</u>, those in the highest were associated with lower ASI (β = −0.083 m/s, 95% CI: −0.14 to −0.03, p = 0.005). Participants in the third and fourth NDVI greenness exposure quartiles were also associated with lower ASI (β = −0.074 m/s, −0.14 to −0.01, p < 0.020 for the third and β = −0.293 m/s, −0.36 to −0.23, p < 0.001 for the fourth quartiles in reference to the first). The inverse association between NDVI greenness and ASI was more pronounced among women (p < 0.001), older adults (p = 0.011) and among participants in the highest walkability quartile (p < 0.001).
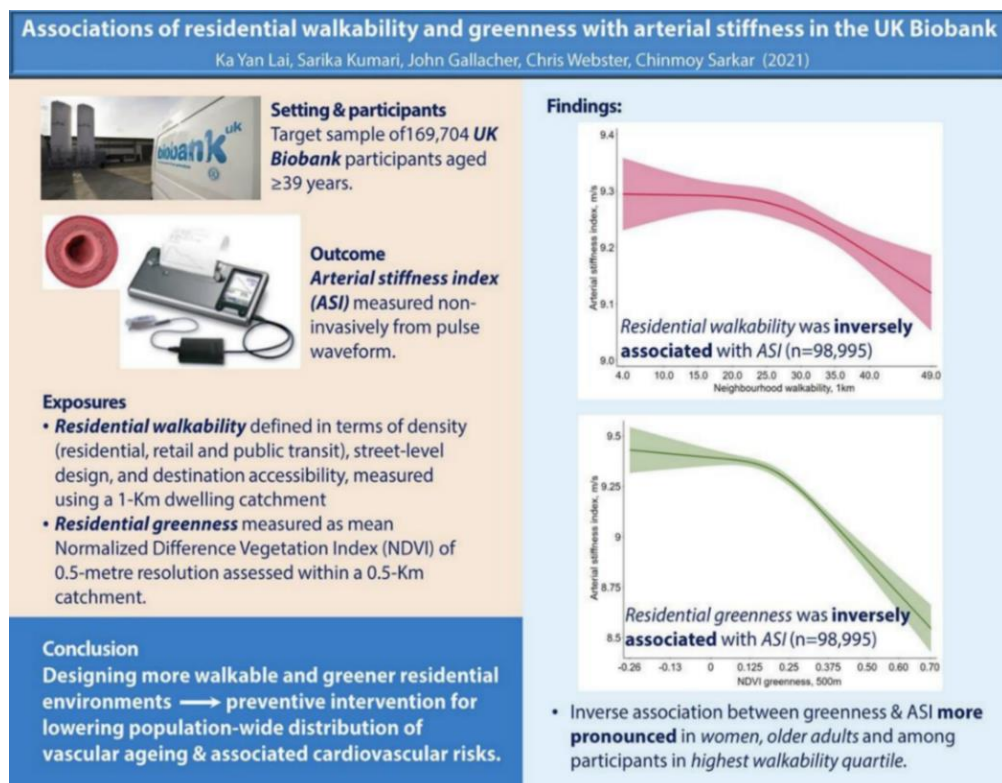
Conclusion: Designing more walkable and greener residential environments can be a preventive intervention aimed at lowering the population distribution of vascular ageing and associated cardiovascular risks.

Keywords: Arterial stiffness, Walkability, NDVI greenness, built environment, UK Biobank, UKBUMP

3. Dr X.C. Chen, Dean Webster and Dr Chinmoy Sarkar

- have the following papers accepted for publication:

(i) **Chen, X. C.**, **Sarkar, C.**, **Webster, C.**, Ward, T., Ho, K. F. (2021). Characteristics and health risks of personal exposure to particle-bound PAHs for Hong Kong adult residents: From ambient pollution to indoor exposure. *Indoor Air* (accepted-in-press, manuscript ID: INA-21-07-390.R3).

Abstract: Research on individual level polycyclic aromatic hydrocarbons (PAHs) exposure is scarce. Moreover, the independent contribution of ambient- and indoor-origin PAHs to personal exposure remains poorly studied. We performed simultaneous ambient, residential indoor, and personal exposure measurements in a panel of healthy adults to investigate particle-bound PAHs, focusing on their carcinogenic congeners (cPAHs). Average PAH concentrations were much higher in ambient and residential indoor than personal exposure, with distinct seasonal variations. We employed chrysene as a tracer to investigate residential indoor and personal PAHs exposure by origin. Personal cPAH exposure was largely attributable to ambient-origin exposures (95.8%), whereas a considerable proportion of residential indoor PAHs was likely attributable to indoor emissions (33.8%). Benzo[a]pyrene equivalent (BaPeq) concentrations of cPAH accounted for 95.2%–95.6% of total carcinogenic potential. Uncertainties in estimated PAHs (and BaPeq) exposure and cancer risks for adults were calculated using the Monte Carlo simulation. Cancer risks attributable to ambient, residential indoor, and personal cPAH inhalation exposures ranged from 4.0×10^{-6} to 1.0×10^{-5}. A time-activity weighted model was employed for personal PAH exposure estimations. Estimated cPAH exposures demonstrate high cancer risks for adults in Hong Kong, suggesting that exposure to indoor-generated PAHs should be of great concern to the general population.

(ii) **Chen, X. C.**, **Sarkar, C.**, **Webster, C.**, Ward, T., Ho, K. F. (2021). Health risks of adults in Hong Kong related to inhalation of particle-bound heavy metal(loid)s. *Air Quality, Atmosphere & Health* (accepted-in-press, manuscript ID: AIRQ-D-21-00184R1).

Abstract: Heterogeneity between ambient and personal exposure to heavy metals has been documented. However, few studies have investigated potential health risks posed by inhalational exposure to airborne heavy metal(loid)s at the individual level. A total of 404 personal fine particles (PM2.5) samples were collected from 61 adult residents (aged 18–63 years) in Hong Kong during 2014–2015. Heavy metal(loid)s were analyzed using Energy Dispersive X-Ray Fluorescence. Among the analyzed heavy metal(loid)s, zinc (Zn) was the most abundant component in personal PM2.5, followed by lead (Pb), copper (Cu), and vanadium (V); cobalt (Co) and cadmium (Cd) were not detectable. Health risks of personal exposure to heavy metal(loid)s via inhalation

were assessed for adults, including non-cancer risks that were characterized by hazard quotient (HQ) and hazard index (HI). The results indicated that non-cancer risks of heavy metal(loid)s were attributable to Cu, with a 95th HQ value > 1. Arsenic (As) and hexavalent chromium [Cr (VI)] were also significant contributors to inhalation cancer risks (> 1 × 10-6) for the adult participants. Finally, we employed a Monte Carlo simulation to evaluate the uncertainty associated with health risk assessment. The mean and median upper-bound lifetime inhalation cancer risk associated with exposure to carcinogenic heavy metal(loid)s exceeded the acceptable level (1 × 10-6) for adults. Traffic emission (including non-tailpipe exhaust), shipping emission, and regional pollution were significant sources of heavy metals. The findings suggest that emission controls targeting local vehicles and vessels should be given priority in Hong Kong.

iLab

1. Professor Wilson Lu, Dr Frank Xue and Dr Jinying Xu

   - led a team to win in the 'Professional Research' category of the buildingSMART International (bSI) Awards 2021, with the project 'OpenBIM: Opening the gate for BIM and blockchain integration (OBBi)'. The results were announced on 7 October 2021.

   BIM (Building Information Modeling) is widely recognised as the most important development in the global construction industry over the past years. It is also highly promoted in Hong Kong, as evident in various Policy Addresses. It involves the use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions. Whilst BIM development has achieved unprecedented success, the current BIM is too tied up with profit-seeking vendors.

   The bSI, or known as the 'international home of BIM', is an open, vendor-neutral, and not-for-profit body incorporated in the UK which pledges to promote OpenBIM by developing international standards to make BIM vendor-neutral and more interoperable. The bSI Awards is a prestigious international award programme initiated since 2018 to promote OpenBIM in the global architecture, engineering, and construction industry.

   This year, there were 133 entries, predominantly from developed, BIM-advanced countries/regions, in the nine categories of the Awards, namely asset management, community contribution, construction, design, facility management, handover, professional research, student research and technology. A highly selective jury was formed to shortlist one to four finalists in each category, deliberating their presentations, and finally selecting a single winner from each category.

   The OBBi submitted by iLab is the sole winner in the Professional Research category. It is also the sole winner from Hong Kong across all the 21 finalists.

   About the winning project – OBBi

   Through BIM and blockchain integration, BIM can take information from blockchain, e.g., material provenance, supply chain status, installation instructions, and contracts; and building information can be assigned to blockchain to be used later, e.g., for smart payment, procurement, traceability, or forensic investigation. However, there are three key obstacles. Firstly, existing commercial BIM software and blockchain lack interoperability, which means they cannot talk to each other. Secondly, information will be too redundant if storing BIM in blockchain directly.

And lastly, how to quickly retrieve the information from blockchain and restore it to BIM without data loss is an issue.

The iLab team developed an innovative idea to overcome the above obstacles by converting commercial BIM into OpenBIM format, calculating their changes, and putting the smaller files containing changes in blockchain; one can retrieve the information from blockchain and restore it onto BIM easily.

The team pilots the OBBi in the HKU Wong Chuk Hang (WCH) modular integrated construction (MiC) Student Residence project. The OBBi is being used to track the provenance, production status, logistics status, and assembly status of MiC modules that are produced in Mainland China and then transported to Hong Kong for assembly. By integrating BIM in blockchain, stakeholders need not worry about information tampering and quality disputes as the information in blockchain is guaranteed with authenticity and reliability. During the mock-up process of this pilot project, the OBBi system demonstrates that BIM exchange and versioning can be much faster and more reliable than traditional files. Moreover, OBBi demonstrates its power to re-connect the fragmented AEC processes in MiC projects that have been further exacerbated by the border restrictions resulting from COVID-19.

Three most innovative features of the OBBi: (1) Tidying up OpenBIM format for BIM and blockchain integration; (2) Inventing an innovative methodology to blockchain BIM changes only; and (3) Developing a novel approach to retrieve information from blockchain and restore it to BIM without time delay or information loss. The innovations are exactly what the bSI pursues along its OpenBIM pledge. The jury believes these innovations will advance OpenBIM, and as such, OBBi stood out from all the competing projects.

The award-winning team: (front row from left) Dr Jinying Xu, Professor Wilson Lu and Dr Frank Xue; (back row from left) Mr Liupengfei Wu and Mr Rui Zhao

Full team of iLab
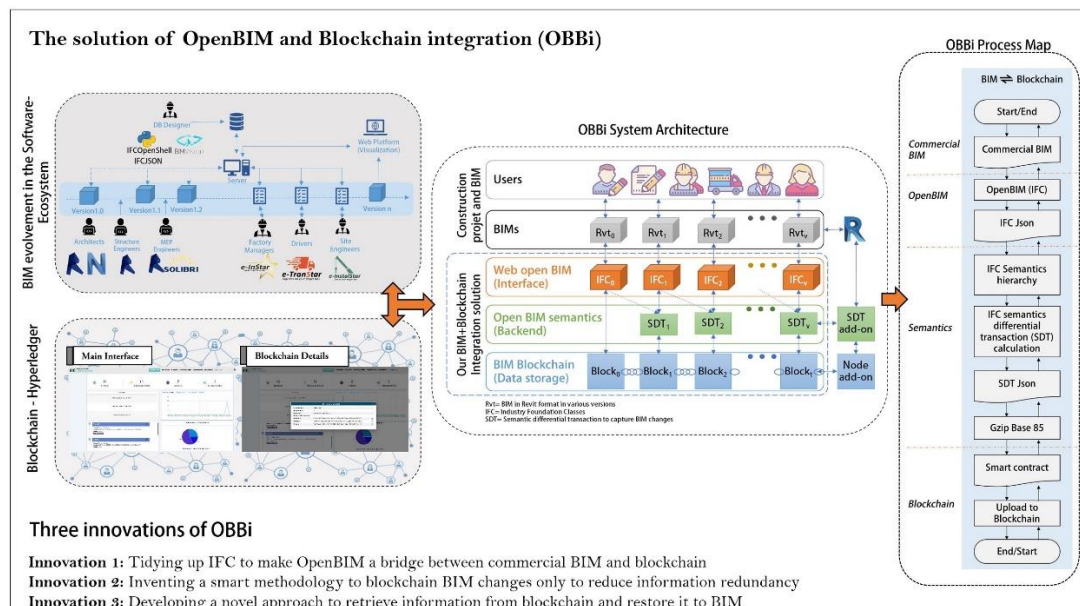
The solution of OpenBIM and Blockchain integration (OBBi)

- Media reports of iLab@HKU team winning in the buildingSMART International Awards 2021, on 21 October 2021:

- [Sing Tao Daily](#)
- [Headline Daily](#)
- [Bastille Post](#)

2. CIC Construction Digitalisation Award 2021

   - On 1 November 2021, iLab received Silver Award in the Training/Research Institute category at the Hong Kong CIC Construction Digitalisation Award (CDA) 2021 Presentation Ceremony.

iLab representatives receiving the Award

CIC Construction Digitalisation Award 2021 was organised by the Hong Kong Construction Industry Council (CIC). It was the first time for CIC to organise the Award, after a series of other prestigious awards such as the CIC Construction Innovation Award and the CIC BIM Competition. CDA is a landmark event in the Hong Kong construction industry. There are two major categories in CDA 2021: the Project category and the Organisation category. Among more than 100 submissions, 20 projects and organisations were being awarded. For more information of the Award, please visit https://cdaward.cic.hk/.

For the Organisation category, there are six sub-categories, i.e., Client, Consultant, Contractor Category A, Contractor Category B, Start-up Company and Training/Research Institute. iLab was awarded Silver Award in the Training/Research Institute sub-category, with the Hong Kong University of Science and Technology winning the Gold Award, the Architectural and Civil Engineering Department at City University of Hong Kong and Transcendence Company Limited winning the Bronze Award.

iLab representatives at the CDA presentation ceremony (From left to right: Dr Nina Yuhan Niu, iLab alumna and Project Manager of HKU President Office; Dr Junjie Chen, Post-Doctoral Fellow of iLab; Dr Fan Xue, Deputy Director of iLab and Assistant Professor; Dr Jinying Xu, Post-Doctoral Fellow of iLab; Dr Zhewen Liu, iLab alumnus and Principal System Engineer at Gammon Construction Ltd.)

iLab in the CDA Presentation Ceremony booklet

3. ISARC 2021 Conference

- A joint paper by PhD students Vikrom Laovisutthichai (REC PhD candidate supervised by Professor Wilson Lu and Professor Stephen Lau) and Maosu (Eric) Li (DUPAD PhD candidate supervised by Professor Anthony Yeh and Dr Frank Xue), titled 'CIM-enabled quantitative view assessment in architectural design and space planning', has been selected as one of the six plenary talks out of more than 170 submitted papers, by the International Symposium on Automation and Robotics in Construction (ISARC) 2021 Technical Committee based on Area Chairs' nominations.

Title: CIM-enabled quantitative view assessment in architectural design and space planning

First author: Vikrom Laovisutthichai

**Corresponding author:** Maosu (Eric) Li

Laovisutthichai, V., **Li, M.**, **Xue, F.**, **Lu, W.**, Tam, K. L., & **Yeh, A. G. O.** (2021). CIM-enabled quantitative view assessment in architectural design and space planning, *Proceedings of the 38th International Symposium on Automation and Robotics in Construction (ISARC)*, 65-72. Dubai, UAE, ISBN 978-952-69524-1-3, ISSN 2413-5844).

Abstract: *A view is among the critical criteria in an architectural design process. Presently, it is assessed by conventional site observation, labour-intensive data collection, and manual data analysis before designing a building mass, plan, façade, openings, and interior space. City Information Model (CIM), with its capabilities to store, visualize, and analyze a wealth of site-related information, has a great potential to support an automated view assessment. However, its realization is nascent, and it has not integrated with architectural space planning in either research or practice. This research, therefore, aims to develop a model through which CIM can be extended to assist view assessment in architectural space planning. By literature review, brainstorming, prototyping, and case study, this research corroborates that by harnessing the power of CIM, the conventional view evaluation can be transformed from qualitative to mix-used. It helps practitioners assess a view and design a space in a more precise and rapid manner. This research also provides the integrated model for view evaluation in architectural space planning with three stages to support the real-world practice. Future studies are recommended to develop the proposed model and integrate it with multiple criteria to advance the generative design.*

Keywords: Architectural design; Generative design; Space planning; View assessment; City information model; Deep learning

The main idea is to apply Eric's award-winning 3D CIM-based Nature View Index (Champion of ESRI Young Scholar 2021) to 'optimise' architectural space planning, with a case study of HKU Business School's new office building.
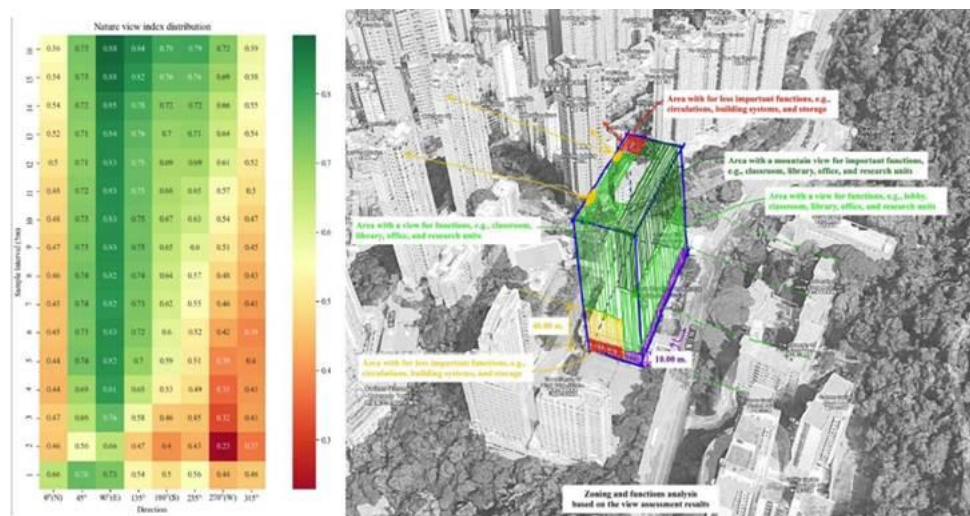
This plenary talk will be developed into a full-length journal article in *Automation in Construction* (IF = 7.700), which is the host journal of the conference organiser IAARC.

- Another research paper by iLab team members Dr Junjie Chen, Dr Shuai Li, Professor Wilson Lu, Professor Donghai Liu, Mr Da Hu and Mr Maohong Tang, has been accepted and presented at the ISARC 2021 Conference:

  Chen, J. J., Li, S., **Lu, W. S.,** Liu, D. H., Hu, D., & **Tang, M. H.** (2021). Markerless augmented reality for facility management: Automated spatial registration based on style transfer generative network. *Proceedings of the 38th International Symposium on Automation and Robotics in Construction (ISARC),* 467-474. https://www.iaarc.org/publications/fulltext/062%20ISARC%202021%20Paper118.pdf
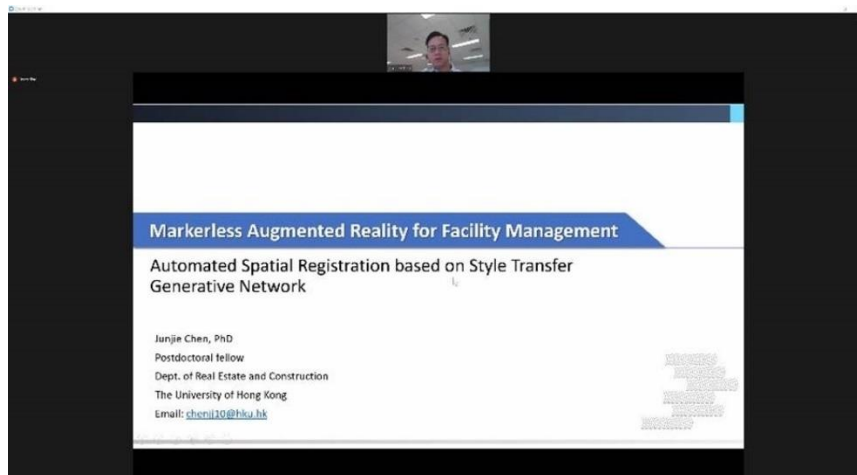
4. iLab researchers have the following papers published or accepted for publication:

   (i) **Bi, W.** (was an RA at iLab and now a PhD student at Cambridge University)**, Lu, W. S., Zhao, Z.** & **Webster, C.** (2021). Combinatorial optimization of construction waste collection and transportation: A case study of Hong Kong. *Resources, Conservation and Recycling*. Accepted. [IF in 2021: 10.204, ranked 11 out of 274 in Environmental Science]

   Abstract: *Although construction waste consistently contributes the highest proportion of all solid waste landfilled, its collection and transportation has received little attention. This research conducts a case study of Hong Kong with the aim of unravelling the causes of ineffective construction waste management from a logistics perspective and developing strategies to improve efficiency of waste collection and transportation. We analyze 112,892 individual trips undertaken by 2,563 construction waste hauling trucks and find three critical issues, namely irrational facility choice, disorganized trip chains, and serious*

underloading. We design an order-to-order distance matrix, based on which we develop a combinatorial approach to optimizing construction waste collection and transportation through (1) optimal facility choice, (2) proper order sequencing, and (3) increased loading ratio. Simulation results indicate that optimal facility choice is most effective of the three strategies, reducing travel distance by 15.2% (15,256 km) and saving 15.3% (21,467 kg) in $CO_{2\text{-}eq}$ emissions. Combining the three strategies creates the best optimization effects, saving 20.3% of travel distance (20,346 km) and 18.2% of $CO_{2\text{-}eq}$ emissions (25,544 kg). Our findings provide valuable insights for construction waste management and suggest strategies (e.g., developing a work dispatch system like Uber or proper vehicle routing algorithms) for improving waste collection efficiency and reducing carbon emissions.

(ii) **Wu, L., Lu, W. S., Xue, F., Li, X., Zhao, R.** & **Tang, M. H.** (2021). Linking permissioned blockchain to Internet-of-Things (IoT) -BIM platform for off-site production management in modular construction. *Computers in Industry*. Accepted. [IF in 2021: 7.635, ranked 9 out of 112 in Computer Science]

Abstract: Traditionally, construction managers were considered more experienced in project management than off-site production management, although the latter is gaining importance with the renaissance of modular construction worldwide. Various Internet of Things (IoT)-enabled Building Information Modelling (BIM) platforms have been developed to facilitate production management by providing better information visibility, traceability, and a more collaborative working environment. Nevertheless, by and large, existing platforms suffer from two shortcomings: (a) the 'single point of failure' problem of IoT networks and (b) how to guarantee the provenance of BIM modifications from multi-sources. This research aims to develop a blockchain-enabled IoT-BIM platform (BIBP) for off-site production management in modular construction (OPM-MC) that can overcome the shortcomings. A design science research method is adopted to develop a three-layer BIBP system architecture. The system architecture is implemented and then compared with the existing IoT-enabled BIM platform. It was found that BIBP can avoid a single point of failure in IoT networks and ensure the provenance of BIM modifications with reduced storage costs in OPM-MC. The system architecture developed in our study can help the industry advance beyond the rhetoric to develop practical blockchain-enabled IoT-BIM applications. Future works are recommended to fine-tune the platform and test and evaluate it in various scenarios.

(iii) **Lu, W. S., Wu, L.,** & **Zhao, R.** (2021). Rebuilding trust in the construction industry: A blockchain-based deployment framework. *International Journal of Construction Management*. Advance online publication. https://doi.org/10.1080/15623599.2021.1974683

Abstract: Trust has been acknowledged as an essential element of inter-organizational relationships, and it also affects the efficiency of work operations. Although the construction industry has been pursuing trust for a long time, trust is still lacking and fragile among stakeholders. Blockchain seems to provide a promising approach through which trust can be rebuilt. This study aims to develop a deployment framework by following which construction stakeholders can develop blockchain-based solutions for rebuilding trust. A design science research (DSR) method is used to develop a blockchain-based framework. Then, the framework is prototyped and illustrated through a case study of construction supervision. It is discovered that the proposed framework can provide a promising approach to fostering trust. One contribution of this research is to articulate a normative vs. naturalistic trust-building spectrum and position blockchain-based trust-building in it. Practically, this research develops a framework that stakeholders can develop blockchain-based solutions.

(iv) **Lu, W. S., Wu, L.,** & **Xue, F.** (2021). Blockchain technology for projects: A multi-criteria decision matrix. *Project Management Journal*, forthcoming.

Abstract: This research aims to develop a multi-criteria decision matrix (MCDM) for project management (PM) professionals, which will support blockchain type selection, evaluate blockchain platforms, and plan blockchain systems. The MCDM is substantiated through a case study that includes a questionnaire and an illustrative example pertinent to the construction industry. It is discovered that in this study, consortium blockchain is superior in dealing with the characteristics of projects, and Hyperledger Fabric is chosen as the best applicable platform. In planning a blockchain-based PM system, PM professionals should consider user requirements such as network participants, principal transactions, communication channels, and smart contracts.

(v) **Xue, F., Li, X., Lu, W. S., Webster, C. J.**, **Che, Z.**, & Lin, L. (2021). Big data-driven pedestrian analytics: Unsupervised clustering and relational query based on Tencent street view photographs. *ISPRS International Journal of Geo-Information*, *10*(8), 561. http://dx.doi.org/10.3390/ijgi10080561

Abstract: Recent technological advancements in geomatics and mobile sensing have led to various urban big data, such as Tencent street view (TSV) photographs; yet, the urban objects in the big dataset have hitherto been inadequately exploited. This paper aims to propose a pedestrian analytics approach named vectors of uncountable and countable objects for clustering and analysis (VUCCA) for processing 530,000 TSV photographs of Hong Kong Island. First, VUCCA transductively adopts two pre-trained deep models to TSV photographs for extracting pedestrians and surrounding pixels into generalizable semantic vectors of features, including uncountable objects such as vegetation, sky, paved pedestrian path, and guardrail and countable

objects such as cars, trucks, pedestrians, city animals, and traffic lights. Then, the extracted pedestrians are semantically clustered using the vectors, e.g., for understanding where they usually stand. Third, pedestrians are semantically indexed using relations and activities (e.g., walking behind a guardrail, road-crossing, carrying a backpack, or walking a pet) for queries of unstructured photographic instances or natural language clauses. The experiment results showed that the pedestrians detected in the TSV photographs were successfully clustered into meaningful groups and indexed by the semantic vectors. The presented VUCCA can enrich eye-level urban features into computational semantic vectors for pedestrians to enable smart city research in urban geography, urban planning, real estate, transportation, conservation, and other disciplines.

(vi) **Li, X., Lu, W. S., Xue, F., Wu, L., Zhao, R., Lou, J. F.,** & **Xu, J. Y.** (2021). Blockchain-enabled IoT-BIM Platform (BIBP) for supply chain management in modular construction. *ASCE Journal of Construction Engineering and Management*, forthcoming.

Abstract: *Configuring a trustworthy IoT-enabled BIM Platform (IBP) is significant for modular construction to ensure transparency, traceability, and immutability throughout its fragmented supply chain management. However, most current IBPs are designed adopting a centralized system architecture, which fails to achieve a decentralized and effective one to ensure a single point of truth in BIM and prevent a single point of failure in IoT networks. To address this challenge, this study introduces permissioned blockchain with IBP and proposes a novel service-oriented system architecture of blockchain-enabled IoT-BIM platform (BIBP) for the data-information-knowledge (DIK) driven supply chain management in modular construction. Firstly, Infrastructure as a Service (IaaS) is designed with hardware, core technologies, and protocols to offer accurate data from daily practice to blockchain BIM. Blockchain BIM as a Service (BaaS) is then developed within the permissioned blockchain to ease the interoperability of the information, semantics, and meaningful inferences. Furthermore, Software as a Service (SaaS) is configured with decentralized applications to achieve knowledgeable operations or processes with a crash fault-tolerant consensus mechanism. The demonstrative case study in a modular student residence project evaluates the proposed BIBP system prototype with the performance analysis of storage cost, throughput, latency, privacy, and feedback from stakeholders. The results indicate that BIBP has an effective system architecture with acceptable throughput and latency, can save storage costs to achieve a single point of truth in BIM, and avoid a single point of failure for IoT networks with privacy and security preserving mechanisms.*

(vii) Ye, M., **Lu, W. S.**, & **Xue, F.** (2021). Does institutional distance matter to environmental and social practices in host countries? Evidence from

international construction companies. *ASCE Journal of Construction Engineering and Management*, forthcoming.

Abstract: Construction businesses expanding internationally often need to devise corporate social responsibility (CSR) as an indispensable component of their competitive strategies. Companies will customize their CSR programmes in line with host countries' institutional environments, meanwhile, this customization will be unavoidably influenced by the institutions at home countries. This research aims to explore whether the institutional distance between the home and host countries matters to CSR, in particular its related environmental and social practices. Data regarding the CSR practices in host countries are extracted from CSR/sustainability reports by using content analysis and text mining. Logistic regression models are then applied to test the roles of institutional distance on the two types of CSR practices. It is found that the institutional distance has no impact on environmental practices in host countries, but the embedded contexts of host countries positively affect the practices. It is also found that the institutional distance is positively correlated with social practices; however, the positive relationship is less pronounced when the host country's development level is higher. The novelty of this research lies in considering both host countries' contexts and the institutional distance. The findings offer companies new insights on how to engage in environmental and social practices and develop CSR strategies in international construction markets.

(viii) **Laovisutthichai, V.,** & **Lu, W. S.** (2021). Architectural design for manufacturing and assembly for sustainability. In S. S. Y. Lau, J. Li, S. Hao, S. Lu (Eds.), *Design and Technological Applications in Sustainable Architecture. Strategies for Sustainability* (pp. 219-233). Springer, Cham. https://doi.org/10.1007/978-3-030-80034-5_15

Abstract: The United Nations Sustainable Development Goals (SDGs) are strenuously pursued around the globe. The architecture, engineering, and construction (AEC) industry has also attempted to develop its strategy for soft-landing these goals. Design for Manufacturing and Assembly (DfMA) presents enormous potentials for achieving sustainability in the AEC industry. However, DfMA for sustainability has not been well discussed in either literature or practice. This chapter aims to develop an integrated DfMA process to achieve the SDGs in the AEC industry. By reviewing literature, visiting two case studies, and referring to the RIBA's (Royal Institute of British Architects) Plan of Work 2020, this research ratifies the implementation of 11 DfMA suggestions during four design stages to achieve the four SDGs, including good health and well-being, sustainable life cycle cost, net-zero embodied carbon, and sustainable land use and ecology. DfMA can be employed by both cases for sustainable building construction and renovation, but their implementation processes are dissimilar depending on the

reinterpretation and adaptation for a specific project context. Future research is recommended to investigate other sustainable design methods and assistive tools to manage the complication of DfMA practice.

(ix) **Chen, J. J., Lu, W. S., Yuan, L., Wu, Y. J.,** & **Xue, F.** (2022). Estimating construction waste truck payload volume using monocular vision. *Resources, Conservation and Recycling, 177*, 106013, ISSN 0921-3449. https://doi.org/10.1016/j.resconrec.2021.106013 [IF in 2021: 10.204, ranked 11 out of 274 in Environmental Science]

Abstract: *Quantifying truck-loaded materials is a problem in many industrial operations. In construction and demolition waste (CDW) management, inspectors at disposal facilities are often required to measure the amount of different waste components loaded by incoming trucks to determine admissibility. Due to the bulky and mixed nature of construction materials, accurate quantification of specific waste categories without sacrificing operability in the field is a challenge. This study proposes a CDW volume estimation algorithm based on monocular vision which can automatically quantify from a single image the amount of specific material components, e.g., rock, gravel, and wood, in waste mixtures. The algorithm achieves a relative error of 0.065 in calculating truck bucket dimensions, and a relative error of 0.169 in estimating material-level construction waste volume. It takes 3.3 s in average to process one image. In applying the algorithm to analyze 2,914 waste truckloads received by an off-site sorting facility in Hong Kong, we observe that the facility entrance received around 800.0 m^3 CDW per day of which about 10.8 m^3 were rejected. Since non-inert wood/cardboard accounts for the highest proportion among all material types, this may imply that many waste dumps accepted by the facility may have been in violation of the admissibility criteria. The study contributes to the knowledge body by providing a novel, non-destructive approach to quantifying CDW via monocular vision. It can be extended to address the general problem of truck payload quantification in scenarios such as road construction, warehouse inventory management, and logistics and supply chain management.*

(x) **Lu, W. S., Chen, J. J.,** & **Xue, F.** (2022). Using computer vision to recognize composition of construction waste mixtures: A semantic segmentation approach. *Resources, Conservation and Recycling, 178*, 106022. https://doi.org/10.1016/j.resconrec.2021.106022 [IF in 2021: 10.204, ranked 11 out of 274 in Environmental Science]

Abstract*: Timely and accurate recognition of construction waste (CW) composition can provide yardstick information for its subsequent management (e.g., segregation, determining proper disposal destination). Increasingly, smart technologies such as computer vision (CV), robotics, and artificial intelligence (AI) are deployed to automate*

waste composition recognition. Existing studies focus on individual waste objects in well-controlled environments, but do not consider the complexity of the real-life scenarios. This research takes the challenges of the mixture and clutter nature of CW as a departure point and attempts to automate CW composition recognition by using CV technologies. Firstly, meticulous data collection, cleansing, and annotation efforts are made to create a high-quality CW dataset comprising 5,366 images. Then, a state-of-the-art CV semantic segmentation technique, DeepLabv3+, is introduced to develop a CW segmentation model. Finally, several training hyperparameters are tested via orthogonal experiments to calibrate the model performance. The proposed approach achieved a mean Intersection over Union (mIoU) of 0.56 in segmenting nine types of materials with a time performance of 0.51s per image. The approach was found to be robust to variation of illumination and vehicle types. The study contributes to the important problem of material composition recognition, formalizing a deep learning-based semantic segmentation approach for CW composition recognition in complex environments. It paves the way for better CW management, particularly in engaging robotics, in the future. The trained models are hosted on GitHub, based on which researchers can further finetune for their specific applications.

5. **Webster, C., Lou, J.F., Peng, Z.Y.,** and **Lu, W.S.**

   - published two articles in *Hong Kong Economic Times*. These are amongst the series of knowledge exchange (KE) activities based on the academic publications from the team's Strategic Public Policy Research (SPPR) project:

   (i) 'Recycling construction waste material to enable the "zero waste" Greater Bay Area', on 28 August 2021. Read Online.
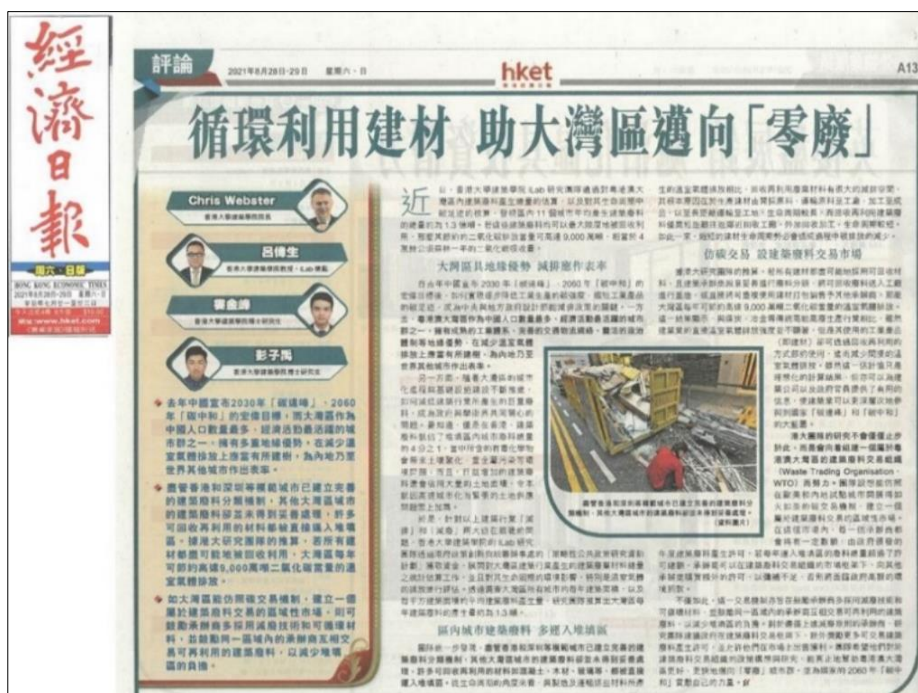
(ii) 'Investigating waste trading in the Greater Bay Area to potentially supply the "Lantau Tomorrow" project', on 4 September 2021. [Read Online.](#)

Ronald Coase Centre for Property Rights Research

1. Professor K W Chau

   - shared his view on the HKSAR Government's Northern Metropolis Development Strategy and introduced the ideas of 'land readjustment' and 'land bonds' in the RTHK programme 'Letter To Hong Kong', on 16 October 2021:
   https://www.rthk.hk/radio/radio1/programme/hkletter/episode/777758
   https://app3.rthk.hk/special/pau/article.php?aid=4463

   More media coverage:
   - Sing Tao Daily
   - Master Insight

Rural Urban Framework

1. Joshua Bolchover and John Lin

   - have won this year's TRANSFER Architecture Video Award with their short film *Split Lives*, which depicts the vernacular typology of the underground dug-out earth houses in northern China. These dwellings have born witness to the radical transformation occurring across China's once rural landscape.

Urban Analytics and Interventions Research Lab

1. Jianting Zhao (PhD candidate supervised by Dr Guibo Sun and Dean Webster)

   - has received the 2021 International Association for China Planning (IACP) Best Student Paper Award, for her entry below:

   Zhao, J., **Sun, G.**, **Webster, C**. (2020). Walkability scoring: Why and how does a three-dimensional pedestrian network matter? *Environment and Planning B*: *Urban Analytics and City Science.* DOI: https://doi.org/10.1177/2399808320977871
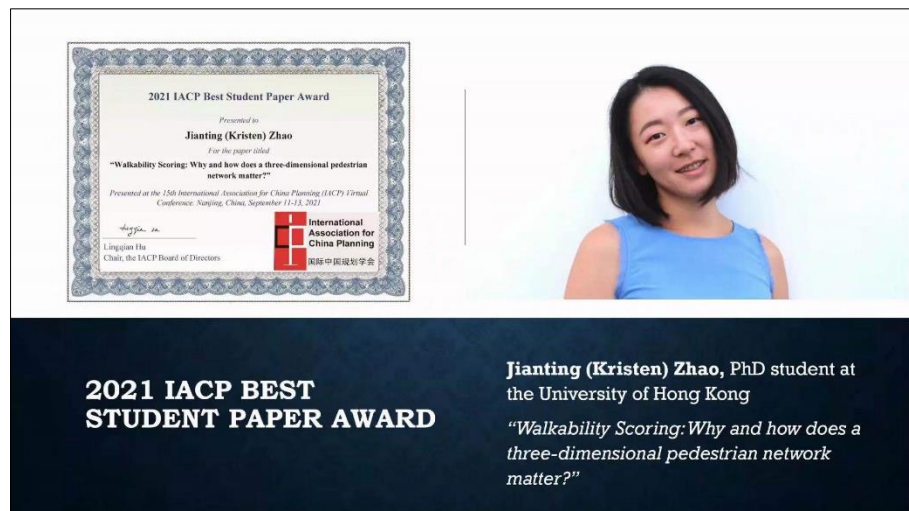
2. Dr Guibo Sun

   - was a session chair of Transit-oriented Development (TOD) in the 2021 IACP meeting on 11 September, where he also presented his research on 'TOD for health of older people in high-density cities'.