# VINCENT GAN (Dr)

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## ACADEMIC/PROFESSIONAL QUALIFICATIONS

- PhD in Civil Engineering (2016), Hong Kong University of Science and Technology
- Professional Certificates in Machine Learning (2019), Massachusetts Institute of Technology (MIT)
- MSc in Civil Engineering (2012), Hong Kong University of Science and Technology
- BEng in Architecture (2011), Huazhong University of Science and Technology
- BMgt in Construction Engineering (2011), China University of Geoscience

## ACADEMIC EXPERIENCE

- Assistant Professor, National University of Singapore, Singapore (09.2020 - present)
- Guest Lecturer, University College London, UK (2.2023)
- Associate Member, American Society of Civil Engineers (ASCE), US (1.2019 - present)
- Visiting Lecturer, Imperial College London, UK (9.2019 - 11.2019)
- Visiting Academic, Purdue University, US (6.2019 - 9.2019)
- Research Assistant Professor & Research Fellow, Hong Kong University of Science and Technology (6.2017 – 5.2020)

## GRANTS AWARDED TO DATE

- **Principal Investigator**, Automated reconstruction of as-built building information models using LiDAR and deep learning. Singapore Ministry of Education AcRF Tier-1 Grant, S$212,380, 3.2023 – 2.2026.
- **Principal Investigator**, Artificial intelligence assisted Scan-to-BIM for existing buildings in A&A projects. Singapore Ministry of Education AcRF Tier-1 Grant, S$170,000, 3.2020 – 2.2023.
- **Principal Investigator**, BIM and Internet of Things-driven multi-agent system for post-COVID facility operations and optimisation. NUS Start-up Grant, S$179,925, 3.2021 – 2.2024.

(Updated June 2023)

- **Principal Investigator**, Predicting thermal comfort and energy performance of mixed-mode ventilation in buildings using building information modelling. HKUST Initiation Grant, HK$100,000, 2.2018 – 6.2019.
- **Principal Investigator**, Pilot study for measurement of carbon emissions from construction activities and EC from residential development. Swire Properties, S$35,000, 1.2022 – 9.2022.
- **Deputy Project Manager**, Building information modelling-based rebar design optimisation and prefabrication automation. Hong Kong Construction Industry Council Explorative Project Scheme, HK$1,071,800, 6.2019 – 12.2020.
- **Project Manager**, Blended Learning 2.0 for PF2108 Project Cost Management. NUS Teaching Fund, 5.2022 – 3.2023.
- **Co-Principal Investigator**, Multi-agent system and integrated collaborative robots for targeted disinfection over 5G network for Post-COVID facilities management. Singapore Ministry of Education AcRF Tier-1 Grant, S$180,000, 3.2022 – 4.2024.
- **Co-Principal Investigator**, 3T framework for mitigating challenges and enhancing digital twin implementation over 5G network for smart facilities management in Singapore. Singapore Ministry of Education AcRF Tier-1 Grant, S$179,000, 4.2022 – 3.2024.
- **Co-Principal Investigator**, Computer vision for housekeeping on construction site. National Research Foundation under AI Singapore Programme, S$529,794, 10.2022 – 4.2024.

## PUBLICATIONS (SELECTED)

### Book Chapter

1. **Gan, V.J.L.,*** (2023) Deep learning-based framework for reconstruction and optimisation of building information models containing parametric rules. In: Bekdaş, G., Nigdeli, S.M. (eds) Hybrid Metaheuristics in Structural Engineering. Studies in Systems, Decision and Control, Vol. 480. Springer Nature.

### Journal Paper

1. Xiang, C., **Gan, V.J.L.,** Guo, J., Deng, L., (2023) Semi-supervised learning framework for crack segmentation based on contrastive learning and cross pseudo supervision. Measurement. 113091.
2. Hu, D., **Gan, V.J.L.,*** Yin, C., (2023) Robot-assisted mobile scanning for automated 3D reconstruction and point cloud semantic segmentation of building interiors. Automation in Construction. 104949.
3. Cheng, J.C.P., Liu, H., **Gan, V.J.L.,** Das, M., Tao, X., Zhou, S., (2023) Construction cost management using blockchain and encryption. Automation in Construction. 104841.
4. Jiang, F., Ma, J.,* Webster, C.J., Li, X., **Gan, V.J.L.,** (2023) Building layout generation using site-embedded GAN model. Automation in Construction. 104888.
5. Wong, B., Wu, Z., **Gan, V.J.L.,*** Chan, C.M., Cheng, J.C.P.,* (2023) Parametric BIM and optimality criteria methods for automated multi-objective optimisation of structural and energy efficiency. Journal of Building Engineering. 107068.
6. Zhuang, D., **Gan, V.J.L.,*** Tekler, Z., Chong, A., Tian, S., Shi, Xing., (2023) Data-driven predictive control for smart HVAC system in IoT-integrated buildings with time-series forecasting and reinforcement learning. Applied Energy. 120936.

7. Wang, T., **Gan, V.J.L.,*** (2023) Automated joint 3D reconstruction and visual inspection for buildings using computer vision and transfer learning. Automation in Construction. 104810.
8. Yin, C., Yang, B., Cheng, J.C.P., **Gan, V.J.L.,*** Wang, B., Yang, J., (2023) Label-efficient semantic segmentation of large-scale industrial point clouds using weakly supervised learning. Automation in Construction. 104757.
9. Li, M.K., Liu, Y.H., Wong, C.L., **Gan, V.J.L.,*** Cheng, J.C.P., (2023) Automated structural design optimization of steel reinforcement using graph neural network and exploratory genetic algorithms. Automation in Construction. 104677.
10. Wang, T., **Gan, V.J.L.,*** Hu, D., Liu, H., (2022) Digital twin-enabled built environment sensing and monitoring through semantic enrichment of BIM with SensorML. Automation in Construction. 104625.
11. Liu, H., Cheng, J.C.P.,* **Gan, V.J.L.,*** Zhou, S.J., (2022) A novel data-driven framework based on BIM and knowledge graph for automatic model auditing and QTO. Advanced Engineering Informatics. 101757.
12. **Gan, V.J.L.,*** (2022). BIM-based building geometric modelling and automatic generative design for offsite construction. ASCE Journal of Construction Engineering and Management. 148, 040221111.
13. Hu, D., **Gan, V.J.L.,*** Wang, T., Ma, Ling., (2022). Multi-agent robotic system (MARS) for UAV-UGV path planning and automatic sensory data collection in cluttered environments. Building and Environment. 109349.
14. Yin, C., Cheng, J.C.P.,* Wang, B., **Gan, V.J.L.,*** (2022). Automated classification of piping components from 3D LiDAR point clouds using SE-PseudoGrid. Automation in Construction. 104300.
15. Zhuang, D., Wang, T., **Gan, V.J.L.,** Zhao, X., Yang, Y., Shi, X.,* (2022). Supervised learning-based assessment of office layout satisfaction in academic buildings. Building and Environment. 109032.
16. **Gan, V.J.L.,*** (2022). BIM-based graph data model for automatic generative design of modular buildings. Automation in Construction. 104062.
17. Liu, H., Cheng, J.C.P.,* **Gan, V.J.L.,*** Zhou, S.J., (2021). A knowledge model-based BIM framework for automatic code-compliant QTO. Automation in Construction. 104024.
18. **Gan, V.J.L.,** Wang, B., Chan, C.M., Asiri, W.U.,* Cheng, J.C.P., (2021). Physics-based, data-driven approach for predicting natural ventilation of high-rise residential buildings. Building Simulation. 2021, 1-20.
19. Li, M.K., Wong, C.L., Liu, Y.H., Chan, C.M., **Gan, V.J.L.,*** Cheng, J.C.P.,* (2021). DfMA-oriented design optimization for steel reinforcement using BIM and hybrid metaheuristic algorithms. Journal of Building Engineering. 103310.
20. He, R., Yang, Z., **Gan, V.J.L.,*** Chen, H., Cao, D., (2021). Mechanism of nano-silica to enhance the robustness and durability of concrete in low air pressure for sustainable civil infrastructures. J. Clean. Prod. 128783.
21. Yin, C., Wang, B., **Gan, V.J.L.,** Wang, M.Z.,* Cheng, J.C.P.,* (2021). Automated semantic segmentation of industrial point clouds using ResPointNet++. Automation in Construction. 103874.

22. **Gan, V.J.L.,*** Luo, H., Tan, Y., Deng, M., Kwok H.L., (2022). BIM and data-driven predictive analysis of optimum thermal comfort for indoor environment. Sensors. 21, 4401.
23. Mangal, M., Li, M., **Gan, V.J.L.,*** Cheng, J.C.P.,* (2021). Automated clash-free optimisation of steel reinforcement in RC frame structures using building information modelling and two-stage genetic algorithm. Automation in Construction. 103676.
24. Liu, Y.H., Li, M.K., Wong, C.L., Chan, C.M., Cheng, J.C.P.,* **Gan, V.J.L.,*** (2021). BIM-BVBS integration with openBIM standards for automatic prefabrication of steel reinforcement. Automation in Construction. 103654.
25. He, R., Li, M., **Gan, V.J.L.,*** Ma. J., (2021). Building information modelling (BIM) enabled computerized design and digital fabrication of industrialized buildings: A case study. J. Clean. Prod. 123505.
26. Yang, Z., He, R., **Gan, V.J.L.,*** Chen, H., Xue, C., (2020). Effect of nano-$SiO_2$ hydrosol on size distribution, coalescence and collapse of entrained air bubbles in fresh cement mortar. Construction and Building Materials. 264, 120277.
27. He, R., Zheng, S., **Gan, V.J.L.,*** Wang, Z., Fang, J., (2020). Damage mechanism and interfacial transition zone characteristics of concrete under sulfate erosion and dry-wet cycles. Construction and Building Materials. 255, 119340.
28. Ma., J., Ding, X., Cheng, J.C.P., Jiang, F., **Gan, V.J.L.,** Xu, Z.,* (2020). A lag-FLSTM deep learning network based on Bayesian optimization for multi-sequential-variant $PM_{2.5}$ prediction. Sustainable Cities and Society. 60, 102237.
29. Afzal, M., Liu, Y., Cheng, J.C.P., **Gan, V.J.L.,*** (2020). Reinforced concrete structural design optimization: A critical review. J. Clean. Prod. 260, 120623.
30. **Gan, V.J.L.,** Lo, I.M.C., Tse, K.T., Cheng, J.C.P., Chan, C.M.,* (2020). Simulation optimisation towards energy efficient green buildings: Current status and future trends. J. Clean. Prod. 254, 120012.
31. Ma., J., Cheng, J.C.P., Jiang, F., **Gan, V.J.L.,** Wang, M., Zhai, C.,* (2020). Real-time detection of wildfire risk caused by powerline vegetation faults using advanced machine learning techniques. Advanced Engineering Informatics. 44, 101070.
32. Ma, J., Ding, Y., Cheng, J.C.P., Jiang, F., Tan, Y., **Gan, V.J.L.,** Wan, Z.,* (2020). Identification of high impact factors of air quality on a national scale using big data and machine learning techniques. J. Clean. Prod. 244, 118955.
33. Ma, J., Ding, Y., Cheng, J.C.P., Tan, Y., **Gan, V.J.L.,** Zhang, J.,* (2019). Analyzing the leading causes of traffic fatalities using XGBoost and grid-based analysis: a city management perspective. IEEE Access. 7, 148059-148072
34. Deng, M., **Gan, V.J.L.,** Singh, J., Joneja, A., Cheng, J.C.P.,* (2019). Automatic generation of fabrication drawings for façade mullions and transoms through BIM models. Advanced Engineering Informatics. 42, 100964.
35. **Gan, V.J.L.,** Tse, K.T., Cheng, J.C.P., Lo, I.M.C., Chan, C.M.,* (2019). Parametric modelling and evolutionary optimization for cost-optimal and low-carbon design of high-rise reinforced concrete buildings. Advanced Engineering Informatics. 42, 100962. (***Structural Excellent Award***)

36. **Gan, V.J.L.,** Wong, H., Tse, K.T., Cheng, J.C.P., Lo, I.M.C., Chan, C.M.,* (2019). Simulation-based evolutionary optimization for energy-efficient layout plan design of high-rise residential buildings. J. Clean. Prod. 231, 1375 - 1388.
37. **Gan, V.J.L.,** Cheng, J.C.P.,* Lo, I.M.C., (2019). A comprehensive approach to mitigation of embodied carbon in reinforced concrete buildings. J. Clean. Prod. 229, 582 - 597.
38. Ma, J., Ding, Y., **Gan, V.J.L.,** Lin, C., Wan, Z.,* (2019). Spatiotemporal prediction of PM2.5 concentrations at different time granularities using IDW-BLSTM. IEEE Access. 7, 107897-107907
39. Asiri, W., Zhang, X., **Gan, V.J.L.,*** Tan, Y., (2019). A holistic framework to utilize natural ventilation to optimize energy performance of high-rise residential buildings. Building and Environment. 153, 218 - 232.
40. Tan, Y., Fang, Y., Zhou, T., **Gan, V.J.L.,** Cheng, J.C.P.,* (2019). BIM-supported 4D acoustic simulation approach to mitigating noise impact on maintenance workers on offshore oil and gas platform. Automation in Construction. 100, 1 - 10.
41. Deng, Y., **Gan, V.J.L.,** Das, M., Cheng, J.C.P.,* Anumba, C., (2019). Integrating 4D BIM and GIS for construction supply chain management. ASCE Journal of Construction Engineering and Management. 145, 04019016.
42. Yang, J., Chen, H.,* Hu, S., **Gan, V.J.L.,** (2019). Experimental studies on the flexural behaviour of steel-concrete composite beams with transverse and longitudinal hidden girders. Engineering Structures. 179, 583 - 594.
43. **Gan, V.J.L.,** Deng, M., Tse, K.T., Chan, C.M., Lo, I.M.C.,* Cheng, J.C.P.,* (2018). Holistic BIM framework for sustainable low carbon design of high-rise buildings. J. Clean. Prod. 195, 1091 - 1104.
44. Chen, W., Chen, K., Cheng, J.C.P.,* Wang, Q., **Gan, V.J.L.,** (2018). BIM-based framework for automatic scheduling of facility maintenance work orders. Automation in Construction. 91, 15 - 30.
45. Cheng, J.C.P., Tan, Y.,* Song, Y., Mei, Z., **Gan, V.J.L.,** Wang, X., (2018). Developing an evacuation evaluation model for offshore oil and gas platforms using BIM and agent-based model. Automation in Construction. 89, 214 - 224.
46. **Gan, V.J.L.,** Chan, C.M., Tse, K.T., Cheng, J.C.P.,* Lo, I.M.C.,* (2017). Sustainability analyses of embodied carbon and construction cost in high-rise buildings using different materials and structural forms. HKIE Transactions. 24, 216 - 227.
47. **Gan, V.J.L.,** Chan, C.M., Tse, K.T., Lo, I.M.C.,* Cheng, J.C.P.,* (2017). A comparative analysis of embodied carbon in high-rise buildings regarding different design parameters. J. Clean. Prod. 161, 663 - 675.
48. **Gan, V.J.L.,** Cheng, J.C.P.,* Lo, I.M.C., Chan, C.M., (2017). Developing a $CO_2$-e accounting method for quantification and analysis of embodied carbon in high-rise buildings. J. Clean. Prod. 141, 825 - 836.
49. **Gan, V.J.L.,** Cheng, J.C.P.,* Lo, I.M.C., (2016). Integrating life cycle assessment and multi-objective optimization for economical and environmentally sustainable supply of aggregate. J. Clean. Prod. 113, 76 - 85.

50. **Gan, V.J.L.,** Cheng, J.C.P.,* (2015). Formulation and analysis of dynamic supply chain of backfill in construction waste management using agent-based modelling. Advanced Engineering Informatics. 29, 878 - 888.
51. Jing, R., Cheng, J.C.P.,* **Gan, V.J.L.,** Woon, K.S., Lo, I.M.C., (2014). Comparison of greenhouse gas emission accounting methods for steel production in China. J. Clean. Prod. 83, 165 - 172.
52. Cheng, J.C.P.,* **Gan, V.J.L.,** (2013). Integrating agent-based human behaviour simulation with building information modelling for building design. International Journal of Engineering & Technology. 5, 473 - 477.

## Papers in Symposium or Conference Proceedings

1. Wang, T., **Gan, V.J.L.,*** (2023). AI-based digital twinning for automated joint 3D scene reconstruction and semantic enrichment. Computing in Civil Engineering: Visualisation, Information Modelling, and Simulation - ASCE International Conference on Computing in Civil Engineering. 25-28 June 2023, Oregon, US.
2. Shao, Z., Goh, Y.M., Tian, J., Lim, Y.G., **Gan, V.J.L.,** (2023). Computer vision-based monitoring of construction site housekeeping. Computing in Civil Engineering: Visualisation, Information Modelling, and Simulation - ASCE International Conference on Computing in Civil Engineering. 25-28 June 2023, Oregon, US.
3. **Gan, V.J.L.,*** Wang, T., Hu, D., Yin, C., (2021). Developing an integrated data model based on IFC and SensorML for Post-COVID facility management. Proceedings of IEEE 23rd International Conference on High Performance Computing and Communications, 7th International Conference on Data Science and Systems, 19th International Conference on Smart City. 17-19 December 2021, China.
4. **Gan, V.J.L.,** Lo, I.M.C., et al., (2019). BIM-based integrated design approach for low carbon green building optimization and sustainable construction. Computing in Civil Engineering: Visualisation, Information Modelling, and Simulation - ASCE International Conference on Computing in Civil Engineering. 17-19 June 2019, Atlanta, US.
5. **Gan, V.J.L.,** Deng, M., Tan, Y., Chen, W., Cheng, J.C.P.,* (2019). BIM-based framework to analyse the effect of natural ventilation on thermal comfort and energy performance in buildings. Energy Procedia. 158, 3319 - 3324.

## Authorship in Research/Technical Reports

- BIM-based rebar design optimization and prefabrication automation. Research Report of Hong Kong Construction Industry Council. 2020. https://www.bim.cic.hk/en/industry_support/page/Research_on_BIM_based_Rebar_Design_Optimization
- A comprehensive HK based carbon labelling scheme covering emission intensive construction materials. Research Report of Hong Kong Construction Industry Council. 2018. https://www.cic.hk/files/page/10391/CICR06-14-A%20Comprehensive%20Hong%20Kong%20Based%20Carbon%20Labelling%20Scheme_RS_023.pdf

### Invited Talks and Seminars

- openBIM-based generative design optimisation and precast construction. Keynote at Department of Real Estate and Construction, Hong Kong University. 10 May 2023, HK.
- Digital twins, robotics, and automation for smart facilities management. Guest Lecture (hold via Zoom) at Bartlett School of Sustainable Construction, University College London. Feb 2023, London, UK.
- AI-assisted digital twins, optimisation, and offsite fabrication of building structures. Seminar invited by Hong Kong Alliance of Built Asset & Environment Information Management Associations (HKABAEIMA). 17 August 2022, HK.

## RESEARCH HONORS AND AWARDS

- **openBIM/openGIS Grand Award**, Award winning project as the deputy project manager: openBIM-based design optimisation and prefabrication automation of steel reinforcement. buildingSMART HK (2022).
- **Structural Excellence Award**, Award winning paper as the first author: Parametric modelling and evolutionary optimization for cost-optimal and low-carbon design of high-rise reinforced concrete buildings. Hong Kong Institution of Engineers (2020).
- **Best Paper Award**, Award winning paper as the corresponding author: Concrete reinforcement modelling with IFC for automated rebar fabrication. International Conference on Construction Engineering and Project Management (2020).
- **Building Information Modelling Award**, Award winning paper/project as the first author: BIM-based framework to analyse the effect of natural ventilation on thermal comfort and energy performance in buildings. Autodesk HK (2017).
- **Best Paper Award**, Award winning paper as the first author: Developing a BIM-based methodology framework for sustainability analysis of low carbon high-rise buildings. International Conference on Construction Engineering and Project Management (2017).
- **Best Paper Award**, Award winning paper as the first author: Developing an agent-based decision support system for construction waste management. International Conference on Civil and Building Engineering Informatics (2013).

## TEACHING

### Courses Taught at National University of Singapore

- Digital Construction (PF1103)
- Project Cost Management (PF2108)
- Advanced Measurement (PF3205)
- AI for the Built Environment (PF3211)
- Digital Transformation with BIM Estimation (CPFM3005)

## Research Students

- Tao Wang, (8.2021 – present). PhD Student (NUS Research Scholarship). Research Topic: Automated 3D reconstruction and semantic segmentation of buildings using 3D computer vision and deep learning.
- Difeng Hu, (8.2021 – present). PhD Student. Research Topic: AI and robot-assisted 3D reconstruction and point cloud segmentation for scene understanding of building interiors.
- Qiao Zheng, (8.2021 – present). Master by Research Student. Research Topic: Automatic geometric quality assessment of construction works using lidar data and artificial intelligence techniques.
- Xiayi Chen (1.2022 – present). Master by Research Student. Research Topic: A data-driven semantic-rich digital twin for monitoring and analysing ACMV performance in tropical environments.
- Kexin Li, (1.2022 – present). PhD Student. Research Topic: AI-assisted automated 3D reconstruction of building information models for large-scale structures.
- Xiuqi Li, (8.2022 – present). PhD Student (Ring-Fenced Industry Research Scholarship). Research Topic: Automated 3D reconstruction of as-built BIM for MEP using deep learning and geometric modelling.
- Hui Lin Oh, (8.2022 – present). Master by Research Student. Research Topic: 5G-powered digital twins for unmanned built environment management.
- Yushuo Wang, (1.2023 – present). PhD Student. Research Topic: LiDAR and robot-assisted mobile scanning for automated 3D scene reconstruction.
- Shuang Du, (Joining). PhD Student (Ring-Fenced Industry Research Scholarship). Research Topic: Robotics and computer vision for automated intelligent management of built environments.

## Postdoctoral Research Fellow

- Asiri Weerasuriya, (8.2018 – 3.2019). Former Postdoctoral Fellow at HKUST.

## Visiting Researchers

- Yongjie Pan, (1.2023 – 12.2023). Visiting PhD from Southeast University. Funded by China Scholarship Council.
- Ruoming Zhai, (10.2021 – 10.2022). Visiting PhD from Wuhan University. Funded by China Scholarship Council.
- Chao Xiang, (8.2021 – 8.2022). Visiting PhD from Hunan University. Funded by China Scholarship Council.
- Changhao Song, (1.2023 – 5.2023). Visiting PhD from Hong Kong University of Science and Technology. Funded by HKUST.
- Dian Zhuang, (8.2021 – 8.2022). Visiting PhD from Southeast University. Funded by China Scholarship Council.
- Ting Liu, (8.2021 – 11.2021). Visiting PhD from Tianjin University. Funded by TJU.

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- Mingkai Li, (3.2019 – 6.2019). Former Visiting Student at HKUST.
- Huaguo Chen, (10.2018 – 12.2018). Former Visiting Student at HKUST.

## PROFESSIONAL SERVICES

- Guest Editor, Digital Twins and Robot Sensing for Smart Construction and Facilities Management, Sensors
- Guest Editor, Smart Cities and Infrastructure Systems by Digital Twins and BIM, Buildings
- Reviewer for the following journals:
    a. Applied Energy
    b. Automation in Construction
    c. Advanced Engineering Informatics
    d. Building and Environment
    e. Energy and Buildings
    f. Engineering Structures
    g. Journal of Building Engineering
    h. ASCE Journal of Construction Engineering and Management
    i. Journal of Cleaner Production
    j. Sustainable Cities and Society
    k. Building Simulation
    l. Renewable & Sustainable Energy Review
- Reviewer, Session Chair & Scientific Committee Member of 8th International Conference on Innovative Production and Construction (IPC) and 8th International Conference on Construction Engineering and Project Management (ICCEPM), December 2020
- Reviewer for the following conferences: ASCE International Conference on Computing in Civil Engineering (i3CE), International Symposium on Automation and Robotics in Construction (ISARC)