For discussion
on 9 May 2025

Legislative Council Panel on Housing

Latest Developments in Innovative Technology Applications in Public Housing Developments

Purpose

This paper briefs Members on the latest developments in the application of innovative technologies in public housing developments by the Hong Kong Housing Authority (HA) and elaborates the achievements of the related initiatives in recent years.

Background

2. HA has always been innovation-driven, leveraging technology to drive industrial innovation in alignment with Hong Kong's development into a smart city. To integrate into national's overall development, HA actively aligns with the national development strategy, seizing opportunities arising from rapid development of innovative technologies in our country, in particular the Artificial Intelligence (AI) revolution driven by digital transformation. HA leverages the vast supply, standardised designs, and high repetitive nature of public housing to integrate innovative technologies and adopts cutting-edge technologies with AI applications, with a view to enhancing speed, quantity, quality, efficiency, reducing costs, and improving construction safety.

3. As early as 2003, HA established a Research and Development (R&D) Steering Committee to enhance construction safety and housing quality through innovative technologies. In recent years, with a view to further driving industry transformation and the development of public housing, we formed an "Action Group on Innovation and Construction Technologies" in 2022. This Action Group oversees the integration of technical advancements and industry innovations, strengthening industry leadership through collaborative frameworks, including partnerships among government, industry, academia, and research institute, as well as pilot projects, and self-developed research programmes.

4. In November 2023, we signed a Memorandum of Understanding (MoU) with the Hong Kong Applied Science and Technology Research Institute (ASTRI) and established a strategic partnership with the Hong Kong Centre for Construction Robotics (HKCRC) in January 2024 to jointly develop a smart tower crane system. We are also preparing to sign a collaboration agreement with the

Nano and Advanced Materials Institute (NAMI) to further expand interdisciplinary collaborations related to public housing development.

5. HA has incorporated various innovative technologies across the planning, design, construction, and inspection stages of works, as well as in the integrated management. These advancements not only enhance efficiency in public housing development, but also drive innovation and foster optimisation and upgrading of the construction sector.

Latest Developments / Specific Technological Items

Planning and Design Stage: AI Empowerment, Precision and Efficiency

*(1) Building Information Modelling (BIM): Aligning with National Strategies and Advancing AI Applications (**Annex 1**)*

6. BIM technology plays a pivotal role in construction projects. By integrating BIM with Geographic Information Systems (GIS), project teams can effectively conduct environmental assessments, including visual appraisal, microclimate simulation, solar radiation analysis, and flood analysis. This optimises the overall layout during the initial planning stages, fully utilising land development potential and creating harmonious and comfortable living space for public housing residents. BIM can also be integrated with other systems. For example, BIM-based Generative Design can utilise artificial intelligence technology through software to quickly generate design proposals that meet specific requirements, based on input design concepts and parameters.

7. Since 2006, HA has widely adopted BIM technology to enhance project quality, construction efficiency, productivity, and safety standards. Since 2021, BIM has been applied comprehensively in all stages of new project developments, including planning, design and construction. Moreover, HA developed the "BIM-enabled Systematic Approach to Foundation Design" (BIM-SAFD) in 2017, enabling automatic generation of foundation designs for structural engineers to evaluate and determine optimal pile locations and depths. The application of this foundation modelling technology has not only significantly improved the efficiency of creating plans, sectional drawings, and construction schedules, but also assisted quantity surveyors in calculating foundation engineering quantities quickly for tender document preparation. Since 2023, HA has been actively exploring the use of Generative Design in project layout planning. By allowing design teams to input development parameters and basic requirements, the software can generate various residential building layouts in BIM automatically, improving the efficiency of works and streamlining decision-making processes.

8. On the other hand, as early as 2017, HA developed and launched the Enterprise Tree Management System, known as ETrMS, integrating various technologies such as GIS, Global Positioning System (GPS), Radio Frequency Identification (RFID), the Internet, and mobile information technology for tree management. This system serves as a platform for storing tree information, which provides HA colleagues and other collaborators with a more efficient means to access tree information, in return facilitating overall planning. In the future, we will explore enhancing ETrMS to a 3D format, integrating tree data with BIM building models. This enhancement will assist inspectors in completing on-site verification accurately and efficiently, while accelerating contractor's follow-up actions. The 3D ETrMS will significantly reduce manpower and time requirements compared with traditional methods.

9. Overall, BIM technology not only significantly reduces costs in the planning, design and construction stages of public housing, but also comprehensively enhances project quality and construction safety standards. In the future, we will integrate BIM with GIS to provide resilient designs, enabling comprehensive analysis for addressing global climate change risks.

*(2) Modular Integrated Construction (MiC) 2.0: Advancing Industry Upgrades Through Cross-Field Collaboration (**Annex 2**)*

10. Since the 1980s, HA has adopted prefabrication technology, and further advanced into volumetric prefabrication in the early 2000s, reducing repair needs by over 50% compared with traditional on-site construction. To continue driving industry innovation, HA introduced first-generation MiC in 2020, transporting free-standing integrated modules that are manufactured in a prefabrication factory to site for installation in a building. This technology has been successfully applied in nine public housing projects under construction, achieving a construction cycle of as short as five days per floor, with a 17% improvement over the previous six-day cycle and doubling on-site worker efficiency compared to traditional prefabrication methods. In 2024, HA and NAMI co-developed the "MiSmartLink" innovative coupling technology for applying in second-generation MiC system. Comparing to first-generation MiC, this technology simplifies on-site procedures, reduces structural wall thickness by up to 15%, aiming to achieve a four-day per floor construction cycle.

11. In advancing the adoption of MiC in public housing development, HA plays a crucial role by actively collaborating with stakeholders in the construction industry (such as major contractors and prefabrication factories), to establish a sustainable MiC ecosystem, which consists of upstream supply chains, transportation logistics, labour skillset transformation and construction

technology advancement. We have also organised industry forums to promote design optimisations and solicited the views of stakeholders, with a view to collectively achieving better buildability, productivity, and cost effectiveness.

12. Furthermore, to align with national development strategies and foster new quality productive forces, HA currently collaborates with three Mainland prefabrication factories and provides them with the design blueprints of second-generation MiC for production and installation trials, with a focus on verifying component production accuracy. Through the integration of automated and intelligent production systems, we have successfully achieved millimetre-level high-precision in prefabricated components manufacturing, significantly enhancing production efficiency and product quality. The collaborating factories are progressively adopting construction robotics, AI, and Internet of Things (IoT) technologies, achieving fully intelligent management from design to production and inspection. This collaboration accelerates AI application in the construction industry and enhances overall technical standards of prefabrication sector in the Greater Bay Area.

13. As MiC components are larger and heavier than traditional prefabricated components, there are challenges for transportation and on-site installation. To effectively account for logistics arrangement in the early planning stage of a project, we engaged The Hong Kong Polytechnic University (HKPU) to conduct general logistics research, leading to the development of a transportation planning guidelines for MiC. This will help assess the potential impacts of MiC projects on surrounding transportation network and assist in selecting suitable MiC projects. Additionally, transporting MiC components from Mainland China to Hong Kong construction sites differs from the traditional delivery of construction materials, resulting in a different impact on local traffic conditions. In response, we collaborated with The University of Hong Kong (HKU) to develop the "e-TranStar 2.0" app for "Just-In-Time (JIT)" delivery of MiC components. This app utilises real-time traffic data to recommend departure times from prefabrication factories, suggest optimised transportation routes to drivers, and estimate arrival times based on pre-planned schedules. This ensures timely delivery and installation of MiC components, avoiding queuing outside sites and minimising traffic impact in nearby area. Overall, it is expected to significantly reduce transportation flow requirements in the entire project.

14. Additionally, we are collaborating with ASTRI to develop an intelligent optical sensing system for precise positioning during the lifting and installation of MiC components. We are also collaborating with HKCRC to develop a smart tower crane system to enhance lifting safety and efficiency.

*(3) Environmental Technology: Smart and Efficient, Empowering Carbon Neutrality (**Annex 3**)*

15. Multi-trade integrated Mechanical, Electrical and Plumbing (MiMEP) is a construction method whereby individual building services modules are prefabricated offsite and then transported to site for installation and connection works. HA has successfully applied this approach in more than ten public housing projects. To promote the widespread adoption of this technology across various public housing development projects, we have been formulating standard technical specifications, reference design drawings, and construction guidelines. HA will continue to accumulate practical experiences and optimise the current MiMEP installation processes. Through standardising modular design, we aim to achieve benefits including reduced on-site installation times, enhanced safety standards, minimised construction waste, and quality assurance for building services systems.

16. In addition, HA has installed photovoltaic (PV) systems in more than 160 domestic blocks since 2011, generating a cumulative total of approximately 7 million kilowatt-hours of electricity. This is equivalent to offsetting about 2 700 tonnes of carbon emissions, which is sufficient to meet the monthly electricity consumption of 25 000 households. HA is actively promoting the use of innovative renewable energy technologies, such as using bi-facial PV panels with passive radiative cooling paints in a pilot project, which are expected to increase the power generation efficiency by over 10% compared to traditional technology. We have also utilised Building-integrated photovoltaic (BIPV) technology in seven pilot projects to explore the most suitable application scenarios for public housing and facilitate wider adoption. If various innovative technologies are widely adopted in future projects, it will further enhance renewable energy production and contribute to carbon neutrality.

17. We will continue to reduce carbon emissions in public housing developments through green design, low-carbon construction methods, adoption of environmentally friendly materials and energy-saving measures, supporting the government's goal of achieving carbon neutrality by 2050.

Construction and Acceptance Stage: AI-Driven Safety and Efficiency Improvements

*(4) Smart Site Safety Systems (4S): AI Alert and Innovative Site Safety Solution (**Annex 4**)*

18. HA has required contractors to introduce intelligent safety monitoring equipment since 2019 to proactively identify potential risks at construction sites. Currently, HA construction sites are fully equipped with multiple safety

protection systems, including smart sensing devices, real-time alert notification systems, and centralised management monitoring platforms. These systems transmit safety alerts to management platforms in real-time, enabling contractors to implement corrective measures immediately. Also, by analysing historical alert records through big data, potential risks can be effectively mitigated in advance, preventing construction accidents before they occur. As of the first quarter of 2025, 39 new construction sites under HA have been certified under the Construction Industry Council's "Smart Site Safety System Labelling Scheme". According to HA's analysis of accident rates per thousand workers for new projects, the implementation of the intelligent safety systems has improved overall site safety performance by 25%.

19. HA continues to promote tripartite collaboration among the construction industry, government departments, and research institutions to develop innovative site safety solutions. To promote the safety of mobile elevating work platform (MEWP), HA has collaborated with the industry to develop a non-invasive safety protection system. Key innovations of this system include external alarm sensing modules, intelligent emergency stop devices, and automatic obstacle-stopping functions. When the platform approaches a hazardous area, the system immediately activates an automatic shutdown mechanism, effectively safeguarding workers and significantly improving overall site safety.

20. In parallel, HA has collaborated with the industry to deepen the use of AI in analysing CCTV footage. By integrating advanced AI technologies with CCTV systems, a dynamic tracking system has been developed for high-altitude falling objects. When the system detects an object in free fall, it will accurately identify the origin of falling objects, records the 3D trajectory path in real time, and automatically notify contractors for evidence retention and follow-up actions.

*(5) Development and Construction Site Mobile System (DCSMS): Enhancing Operational Efficiency through Digitalisation (**Annex 5**)*

21. In 2016, HA self-developed the DCSMS enabling site personnel to input inspection and acceptance data directly on-site and synchronised it with the cloud database. So far, this system has been introduced in five phases, covering 13 mobile and online application modules, and has been adopted in 189 construction contracts. It has fully replaced traditional paper-based workflows, achieving digital transformation. This initiative has significantly streamlined documentation processes for construction personnel, and boosted work efficiency by 13%, while effectively lowering operational costs. Currently, the system's scope has been extended to Mainland prefabrication factories, with plans to integrate it with other management systems.

22. HA recently launched the "Housing Smart Intake (HOST) System" digital service platform, allowing tenants and owners of subsidised sale flats an online tool to report unit defects. This enables contractors to immediately access repair requests and swiftly arrange maintenance work. As of the 2024-25 fiscal year, HA received and processed over 10 400 cases through this platform, covering 13 newly completed public housing estates and Home Ownership Scheme courts.

*(6) Construction Robotics: Mitigating Labour Shortages with AI Technology (**Annex 6**)*

23. To effectively address the structural challenges of an aging skill labour workforce and labour shortages in the construction industry, HA has been piloting the use of construction robots since 2020. As of now, various construction robot systems have been adopted or have been planned to adopt in over 50 construction projects, including robots capable of precise tasks such as plastering, surface polishing, and spray painting at vertical heights of up to 6 meters.

24. In a recent case study, HA tested collaborative robot systems in a public housing project with a standard floor comprising 24 units. Traditionally, eight skilled workers were required for wall finishing tasks, but with the robotic assistance system, the same workload could be completed by only two operators, resulting in over a 50% improvement in overall efficiency while the consistency of construction quality has significantly improved.

25. HA also serves as a validation platform for innovative technologies, supporting the construction industry. For example, a three-in-one wall treatment robot was successfully validated in the HA's pilot project which demonstrated the replicability of this innovative technology, which later facilitated its trial application in overseas residential and car park projects.

26. To promote and showcase the practical application and performance outcomes of construction robots in housing projects, HA will host a Construction Robot Competition in May 2025, which will compare the effectiveness of various robots in performing spray painting tasks. The event will recognise high-performing construction robots and introduce promising new robotic technologies, encouraging contractors to adopt construction robots more extensively and further drive industry development.

27. HA will continue to evaluate the feasibility of introducing various types of construction robots for specialised processes, through the government's "The Construction Innovation and Technology Fund (CITF)", subsidies for contractors adopting construction robots will be expanded. This initiative aims to establish

a new collaborative construction model between humans and robots, effectively addressing skilled labour shortages and an aging workforce, while fostering modern construction safety culture. Additionally, this approach will help transform labour-intensive work patterns and elevate the industry's technological level. By enhancing the sector's image, these efforts will also attract young professional to participate in the industry. HA will continue to collaborate with industry, academia, and research institutions to refine technical standards and training systems, fostering the smooth implementation of human-robot collaboration models and driving further industry development.

*(7) Mobile Mapping System (MMS): Innovating Inspection Workflows with Digital Twin Technology (**Annex 7**)*

28. MMS is an important innovative technology application that integrates advanced reality capture techniques and high-precision measurement equipment, such as high-resolution laser scanners, panoramic cameras, and multi-sensor navigation systems. This system can generate millimetre-level precision 3D point cloud data models. Practical application data shows this technology can effectively reduce traditional visual inspection errors, ensure traceability of engineering records, and significantly improve both inspection work efficiency and document management capabilities.

29. This system offers multiple technological advantages, primarily enabling automated comparisons with BIM and leverages AI algorithms to improve defect detection efficiency by over 50%. Starting from January 2025, this technology has been formally included as a standard specification in the HA's new construction contracts. At the same time, HA is collaborating with the Fire Services Department to apply this technology to fire safety inspection workflows, aiming to establish a more efficient inter-departmental collaboration mechanism. The core value of this technology lies in promoting comprehensive digital transformation of inspection workflows, establishing a visualised construction quality management system, and perfecting data traceability mechanisms throughout the entire project lifecycle.

*(8) Small Unmanned Aircraft (SUA): Intelligent Inspection Technology for Low-Altitude Economic Applications (**Annex 8**)*

30. The SUA systems utilise aerial photogrammetry techniques to convert collected digital images into visualised 3D models. It is further integrated with AI algorithms to accurately pinpoint exterior wall defects. Since 2020, HA has introduced SUA systems equipped with high-resolution imaging devices to conduct external wall inspections in newly construction public housing projects. Starting from 2022, HA formally included SUA exterior wall inspection technology into the standard specification in all new construction contracts. As

of now, this technology has been successfully implemented in nine projects, completing external wall inspections for a total of 17 buildings. Practical verification demonstrates that this technology, combined with AI, not only boosts inspection efficiency by up to 80% but also ensures worker safety. Given the substantial development potential in the low-altitude economy, HA plans to further expand the application of SUA. Future research will explore the integration of AI-assisted SUA into the construction phase, enabling project teams to perform specific monitoring tasks, which is expected to significantly enhance on-site personnel efficiency and improve overall project quality.

Integrated Management: Driving High-Quality Development through Digital Transformation

*(9) HA-Project Information Management and Analytics Platform (HA-PIMAP): AI and Big Data Assisted Decision-Making (**Annex 9**)*

31. In 2022, HA successfully developed the "HA-PIMAP" project information management and analytics platform. This comprehensive platform utilises cloud computing, combines 3D digital mapping with digital twin technology to effectively integrates all public housing development projects under HA. By putting in place BIM, GIS, and various innovative technologies together, the platform supports digital management across the planning, design, construction, and acceptance stages of public housing projects. It significantly enhances data analysis capabilities and improves the efficiency of public housing development. Currently, this platform has been implemented in five active construction sites, with plans to expand to 15 sites in construction stage by the 2025-26 fiscal year.

32. HA-PIMAP platform can automatically retrieve and display records of the entire lifecycle of prefabricated components, covering from production, transportation, to installation, along with worker entry and exit times, construction safety alerts, and other IoT-enabled records, with real-time data updates. It enables project teams to remotely monitor construction progress and environmental changes on each site via the platform, thereby strengthening HA's oversight of contractor performance. HA has introduced and shared the development and application of the platform with the Architectural Services Department, Drainage Services Department, and Electrical and Mechanical Services Department to exploring further interdepartmental collaboration and collectively improve public service efficiency.

33. HA-PIMAP was the only representative from the China Region shortlisted in the public sector and government category (Digital Government) in the Asia Pacific ICT Alliance Awards 2024 and won 1st Runner-up in both the Digital Government category and the Business Data Analytics category. This

achievement highlights HA's efforts and accomplishments in the innovation and technology field on the international stage.

Way Forward

34. To align with the "Digital Government" blueprint initiated by the Digital Policy Office (DPO) established by the Hong Kong SAR Government in 2024, HA will comprehensively implement its digital transformation strategy. Specific measures include deploying the “HA-PIMAP” platform across all new public housing development projects, leveraging AI and digital technologies to reshape its management model for public housing development in Hong Kong. This will enhance operational efficiency and service quality.

35. In response to issues such as the large-scale demand for public housing development, labour shortages in the construction industry, and site safety concerns, HA not only researches and develops replicable and scalable innovative technological solutions, but also actively promotes inter-departmental collaboration and consolidates industry resources to implements scientific research achievements and expands their application scope. With a guiding approach of “vertical integration and horizontal collaboration”, and the operational framework of “proactive deployment and forward-thinking planning”, we maintain a work attitude of “pragmatic progress and keeping pace with the times”, continuously drive the application of innovative technologies, accumulate valuable experience and set industry benchmarks for the upgrade and transformation of the construction sector.

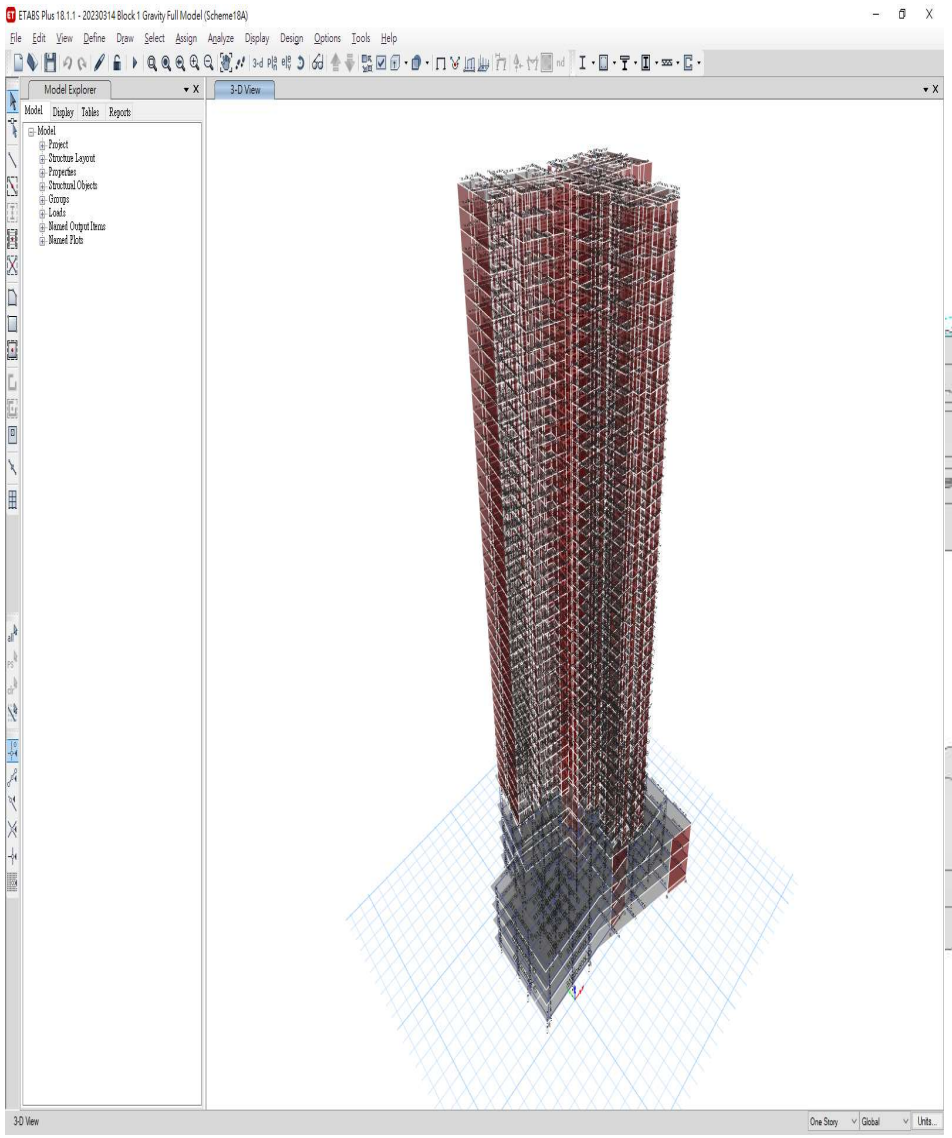
36. Looking ahead, HA will remain committed to its core philosophy of "innovation within inheritance", with a strong focus on leveraging innovative technology to improve cost-effectiveness in construction and driving modernisation across Hong Kong’s construction industry through technological enablement. Efforts will be made to introduce and validate promising new technologies systematically, promote cross-disciplinary integration and knowledge sharing within the construction sector, and ensure that technological innovations effectively translate into tangible benefits for enhancing residents’ living standards. Throughout this transformation, HA will uphold a professional and accountable attitude, striving to balance between technological innovation and public interest. This ensures that the application of technology genuinely serves the community and delivers improved quality and efficiency in public housing development.

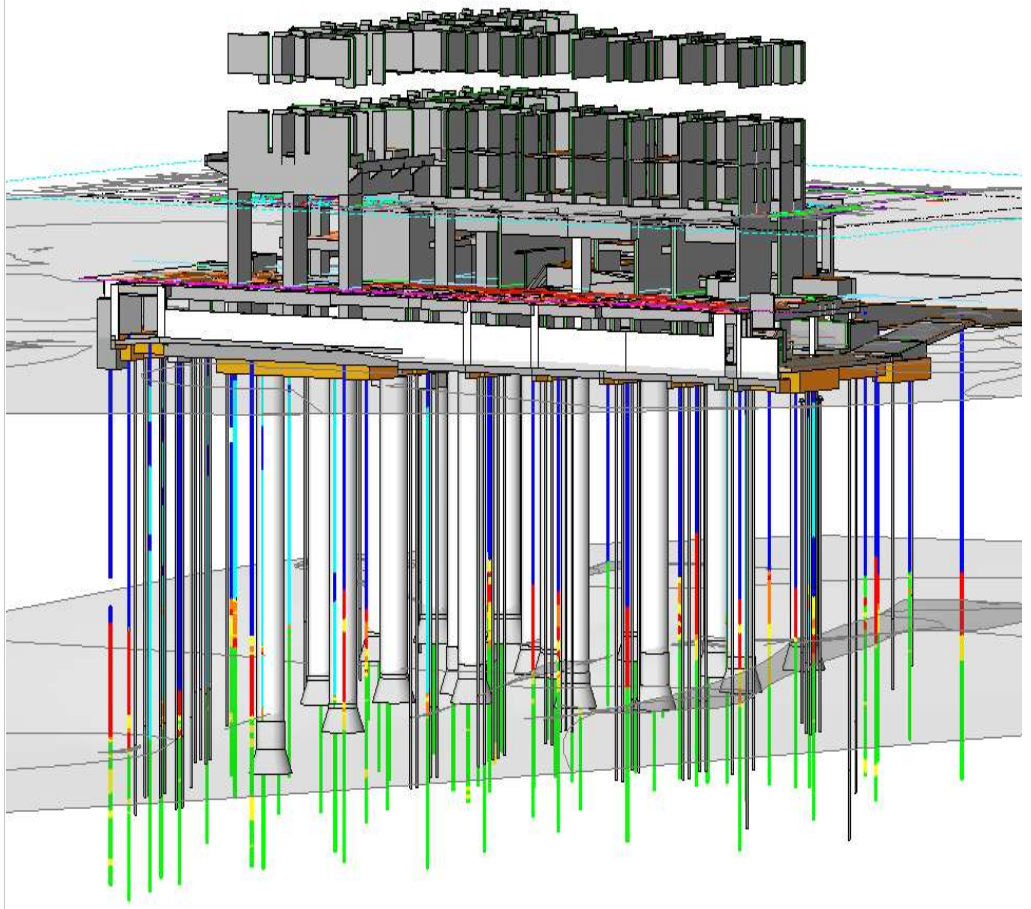
37. Members are invited to note the information in this paper.

Housing Bureau
May 2025

Planning and Design Stage

Building Information Modelling (BIM)

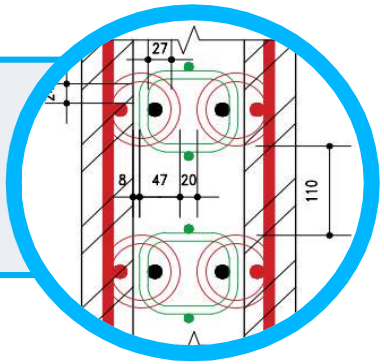




Planning and Design Stage

Second-generation MiC

"MiSmartLink" innovative coupling technology



HA and NAMI co-developed the "MiSmartLink" innovative coupling technology

Planning and Design Stage

Second-generation MiC

HA currently collaborates with three Mainland prefabrication factories for Second-generation MiC production and installation

Planning and Design Stage

Environmental Technology

Prefabrication factory for MiMEP modules

Planning and Design Stage

Environmental Technology

Building-integrated photovoltaic (BIPV) installed on building.

Construction and Acceptance Stage

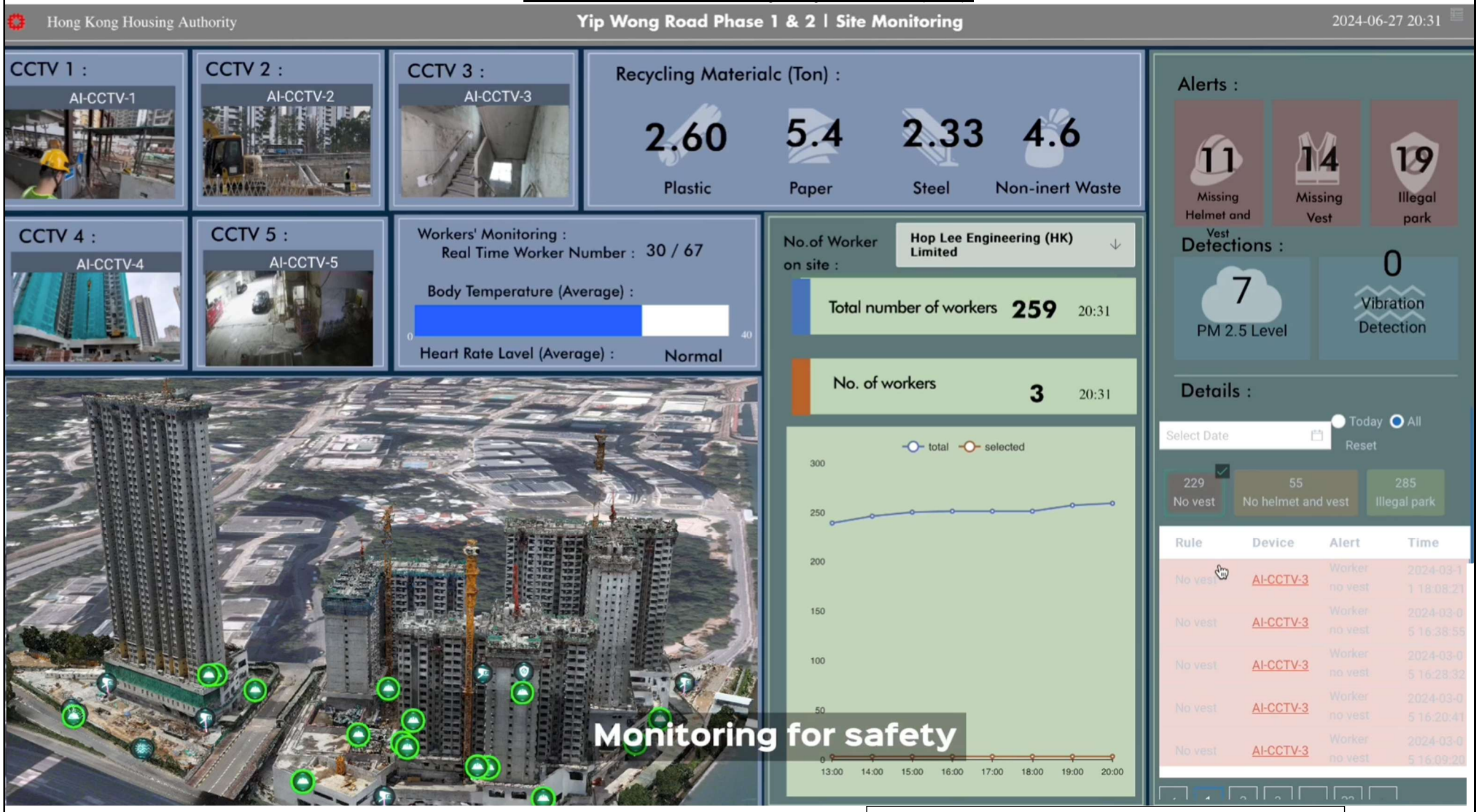
Smart Site Safety Systems(4S)

IoT Technology

Intelligent safety monitoring equipment Design

Construction and Acceptance Stage

Smart Site Safety Systems(4S)



Centralised Management Platform

Intelligent safety monitoring equipment Design

Construction and Acceptance Stage

DCSMS

Request for Inspection

Inspection before Concreting

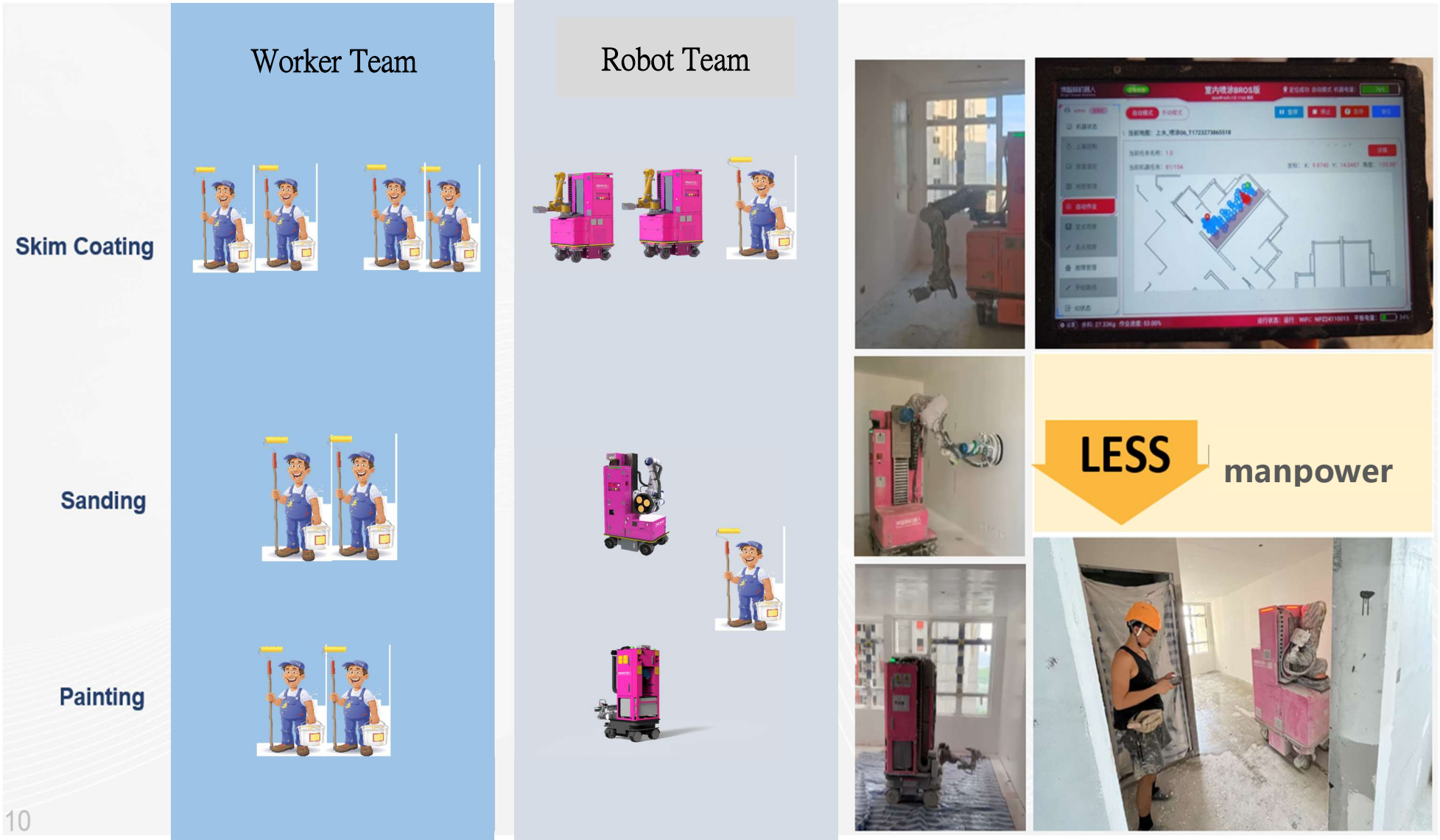
Mobile Record

Photo and Data Record

Relevant drawing indication

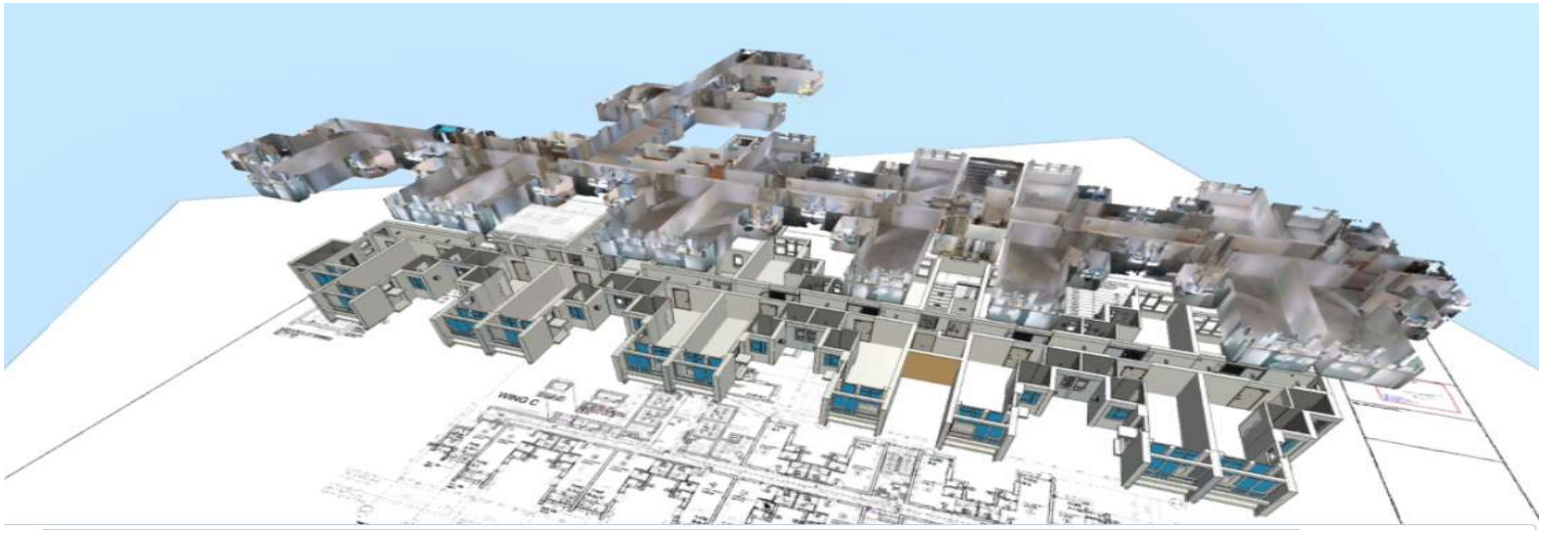
Construction and Acceptance Stage

Construction Robotic



Construction and Acceptance Stage

Mobile Mapping System (MMS)



Mobile Mapping System (MMS): Innovating Inspection Workflows with Digital Twin Technology

Construction and Acceptance Stage

Small Unmanned Aircraft (SUA)

Employing SUA application with AI algorithms to accurately pinpoint exterior wall defects

Integrated Management

HA-PIMAP

HA-Project Information Management and Analytics Platform