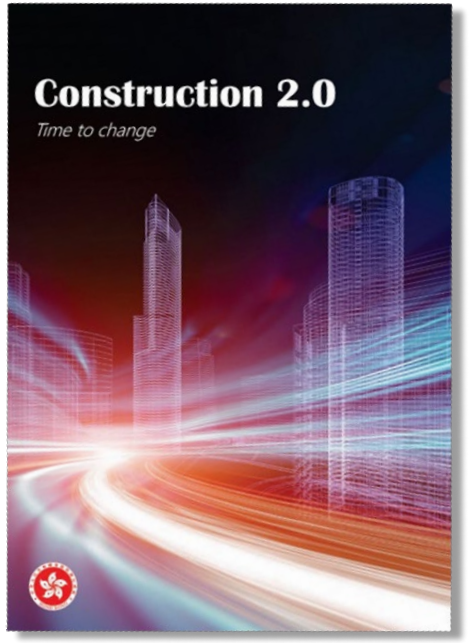
THE UNIVERSITY OF HONG KONG 香港大學
faculty of architecture 建築學院
Department of Real Estate and Construction
房地產及建設系

14 December 2022

MiC logistics and supply chain QA/QC during the COVID-19 pandemic time: A trilogic solution based on BIM and blockchain

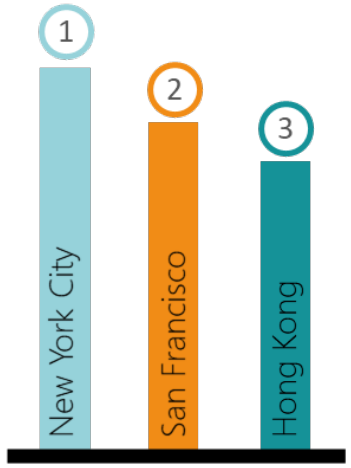
Prof. Wilson Lu
Department of Real Estate and Construction
The University of Hong Kong,
Pokfulam, Hong Kong,

1. Starting from Construction 2.0



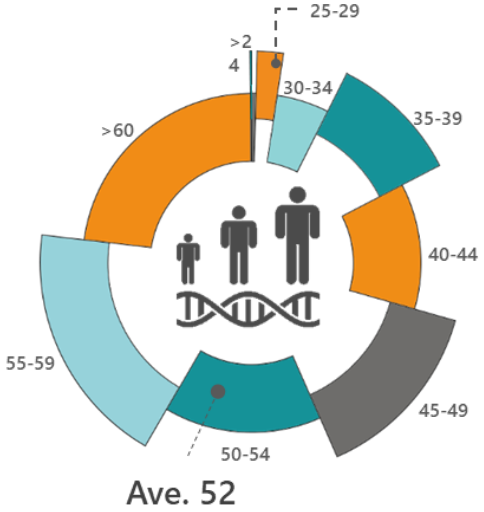
https://www.psgo.gov.hk/assets/pdf/Construction-2-0-en.pdf

With the assistance of KPMG published in Sep 2018



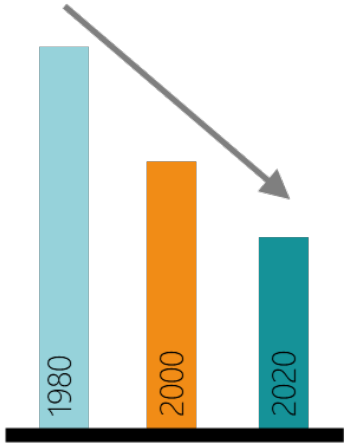
Construction Cost

The Construction cost in HK is the third highest in the world



Aging

Average age of skilled construction workers is 52



Construction Techniques

There is a decrease in construction techniques

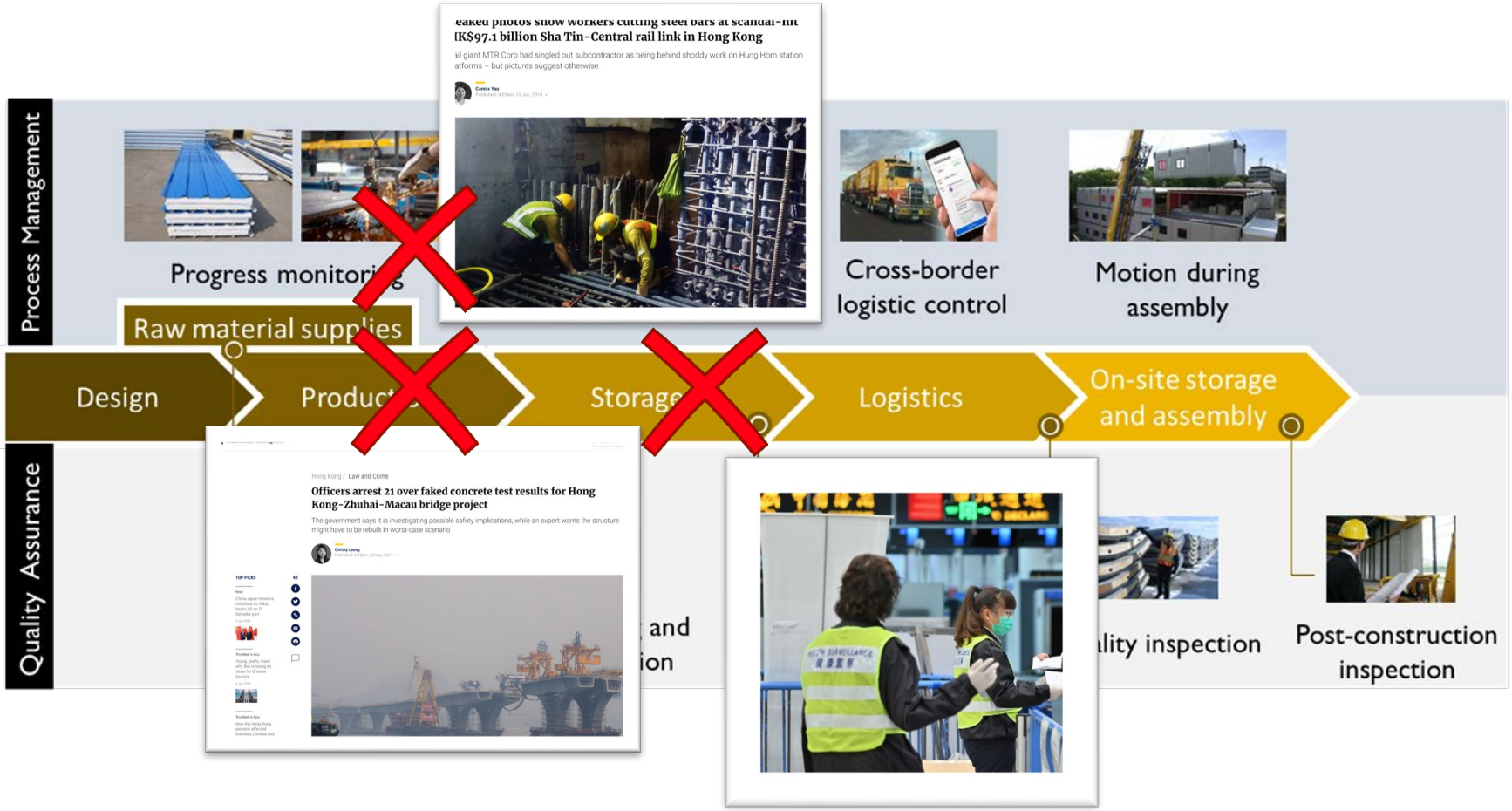
2. MiC as a response to the Construction 2.0 report as a strategy of procurement innovation

Modular Integrated Construction (MiC) is an innovative construction method. By adopting the concept of "factory assembly followed by on-site installation", MiC helps to ease some of the current challenges faced by the local construction industry. In this method, free-standing integrated modules (completed with finishes, fixtures and fittings) are manufactured and assembled in a factory. By transferring on-site construction processes to a controlled factory environment, buildings can be substantially completed off-site. The adverse impacts of weather conditions, scarce labour resources and site constraints can all be substantially reduced. MiC provides a great degree of production quality control, and can improve construction productivity, safety and sustainability.

Source: CIC website

Courtesy: HKU Estate Office

3. MiC logistics and supply chain QA/QC during the difficult time



3. MiC logistics and supply chain QA/QC during the difficult time

Quality inspections required at Mainland factories

Infeasible to dispatch now due to 14 + 14 days quarantines

(Photo source: Authors, SCMP)

4. Our trilogy (MiC 三寶)

Digitalization of MiC

4. Our trilogy (MiC 三寶)

Off-Site Production

- **Digitalized** workflow procedures
- Detailed record of **inspection records** carried out by AP/RSE/RC streams
- **Test reports** uploads
- **Production progress** status

Cross Boarder Logistics

- **Real time tracking** of modules during transportation
- **Pin point** exact location of module
- Estimated **arrival time**

On-Site Installation

- **Real time** update of installation progress
- **Positioning checking** for installed modules
- Recording of **installation time**

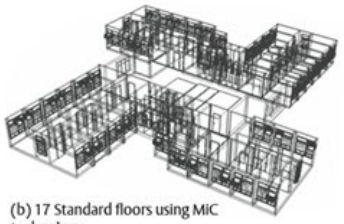
4. Our trilogy (MiC 三寶)

- A 3-storey non-residential podium with common space, canteen, support facilities and car-parking space
- Two 17-floor towers of student residences and staff accommodation
- 1,224 hostel places
- Site Area: 4306 m^2
- NOFA: 14,277 m^2
- CFA: 28,176 m^2

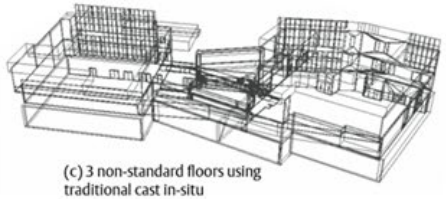
4. Our trilogy (MiC 三寶)

Figure 1 - The Pilot Project

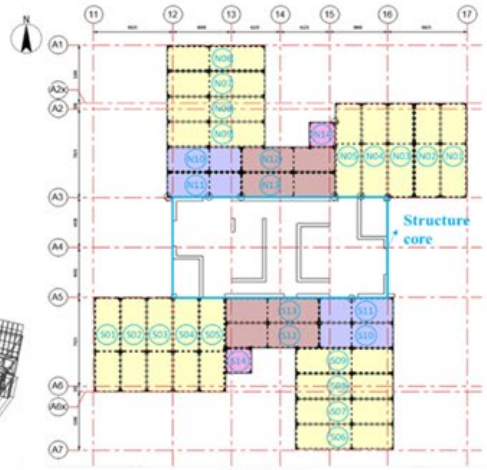
(a) Overall view of HKU's WCH Student Residence project



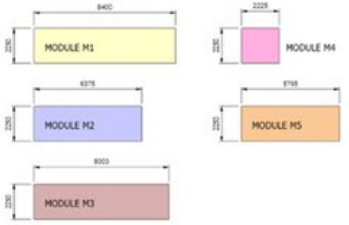
(b) 17 Standard floors using MiC technology



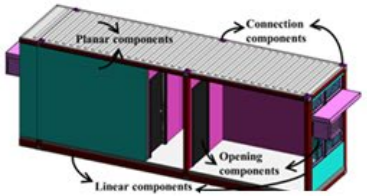
(c) 3 non-standard floors using traditional cast in-situ



(d) Floor plan



(e) Module types



(f) BIM of a typical module

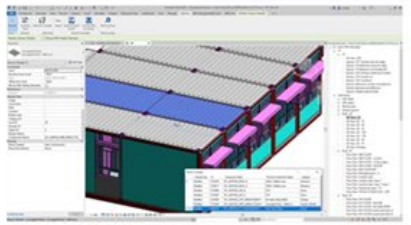
Project Name: HKU's Wong Chuk Hang Student Residence
Functions: A total of 1224 student places and supporting facilities such as canteen, common room, laundry rooms and car park
CFA: 28,176m2
Contract sum: ~HK$1.1 billion
Address: Police School Road, Wong Chuk Hang, Hong Kong
Structure: Two 17-storey tower buildings on top of a 3-storey podium
Construction technology: Modular Integrated Construction (MiC)

buildingSMART Tools used:

IFCJSON IFC2X3

Software Used:

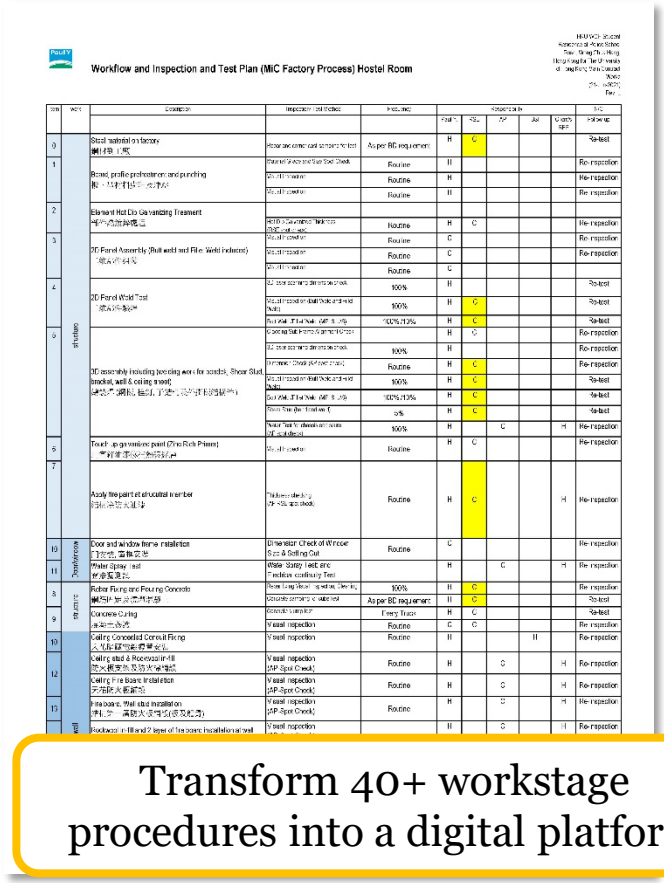
AUTODESK NAVISWORKS REVIT SOLIBRI BIMVision e-InStar HYPERLEDGER

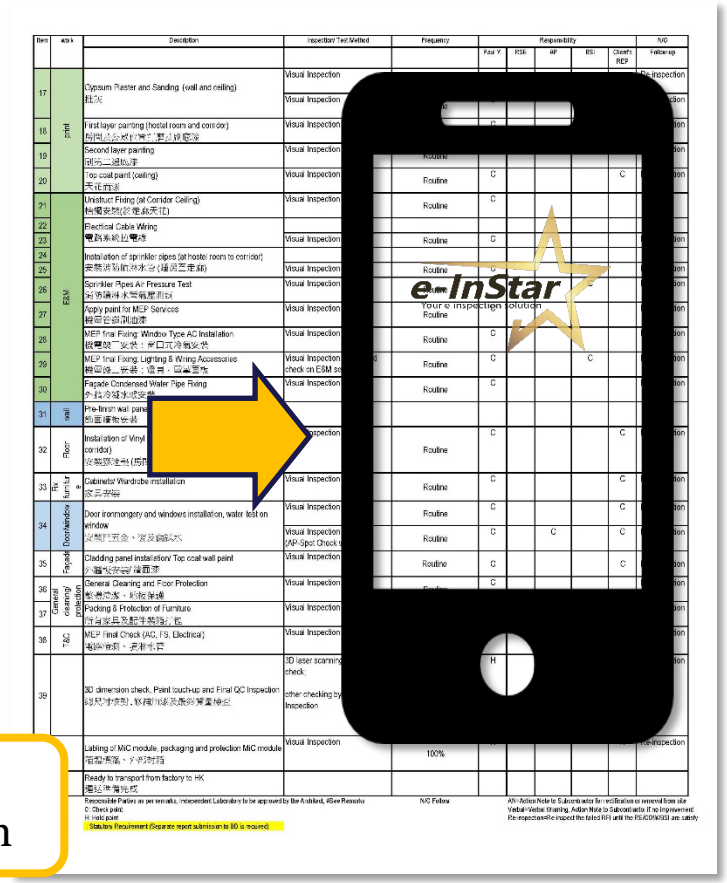


(g) BIM of combinational modules

4. Our trilogy (MiC 三寶)

Off-Site Production Workflow

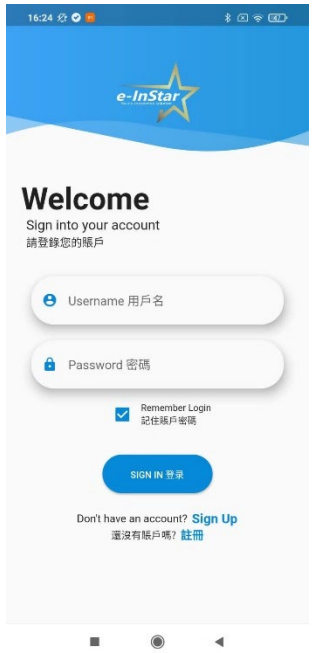




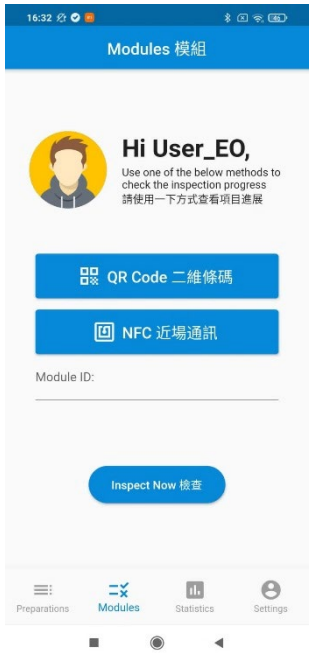
Transform 40+ workstage procedures into a digital platform

4. Our trilogy (MiC 三寶)

Inspection Record



Two Factor Authentication

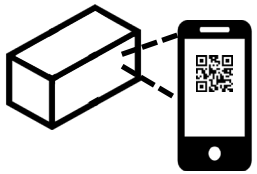


Scan Module ID

Inspection status of module

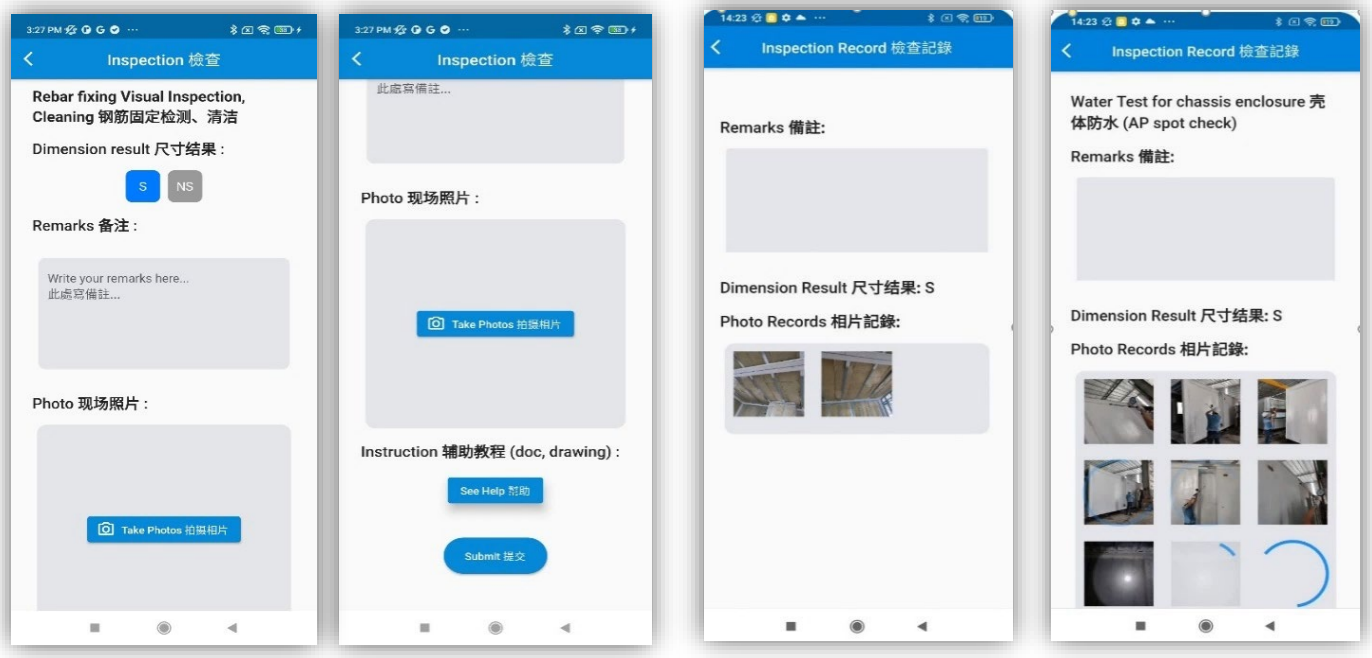
User ID

Fingerprint verification



4. Our trilogy (MiC 三寶)

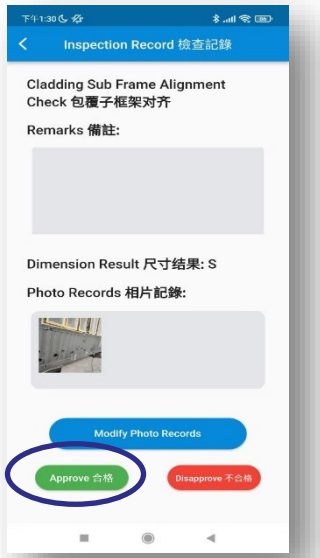
Inspection Record



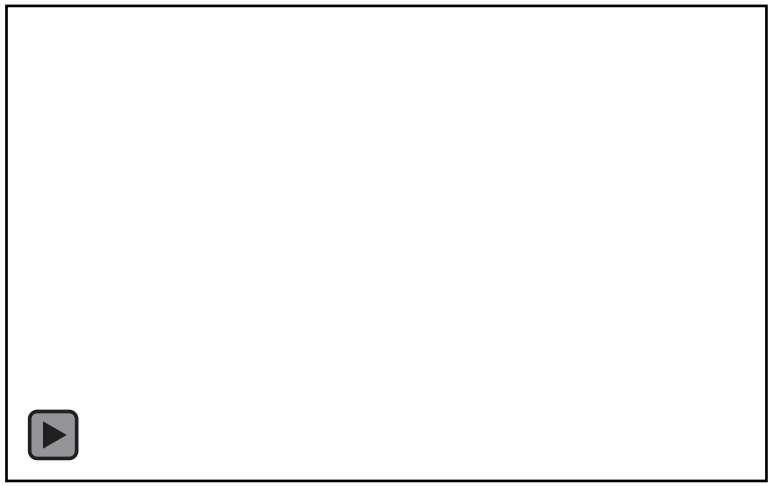
Comment box **Help button** **Photo upload function**

4. Our trilogy (MiC 三寶)

Blockchain visualization

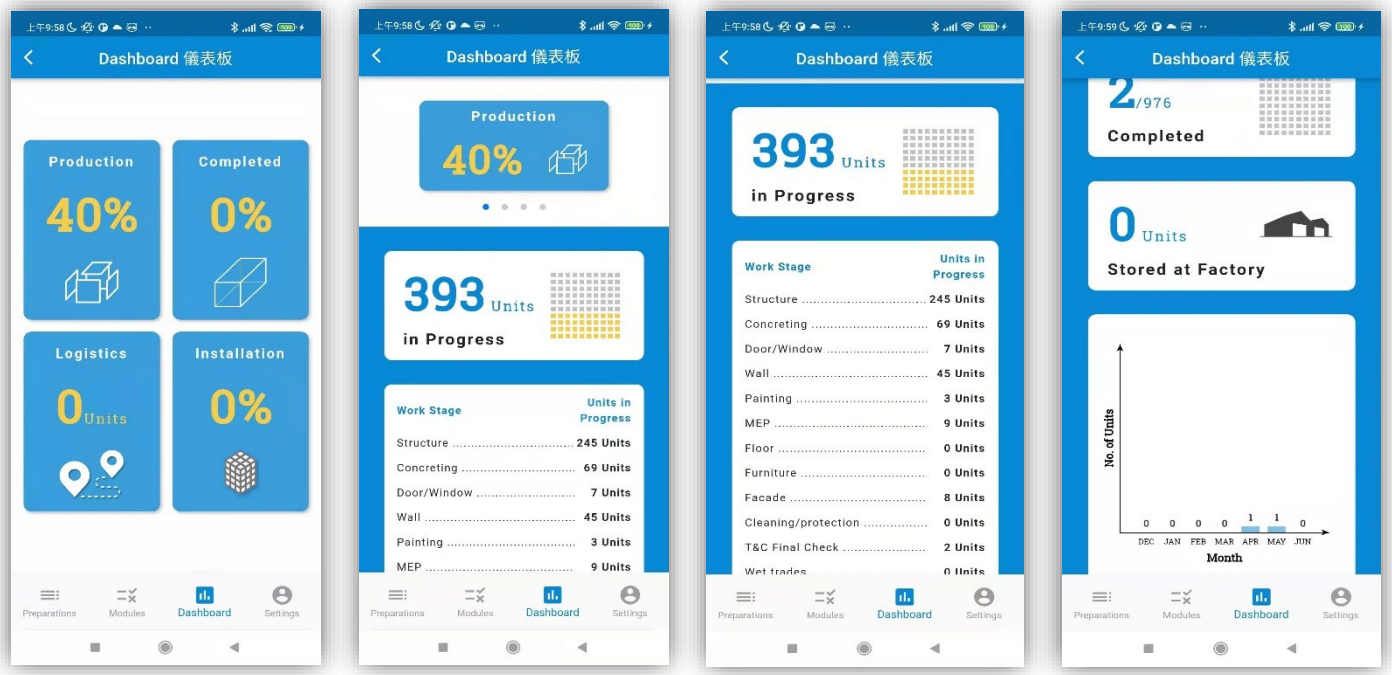


Transaction
(Inspection record)



4. Our trilogy (MiC 三寶)

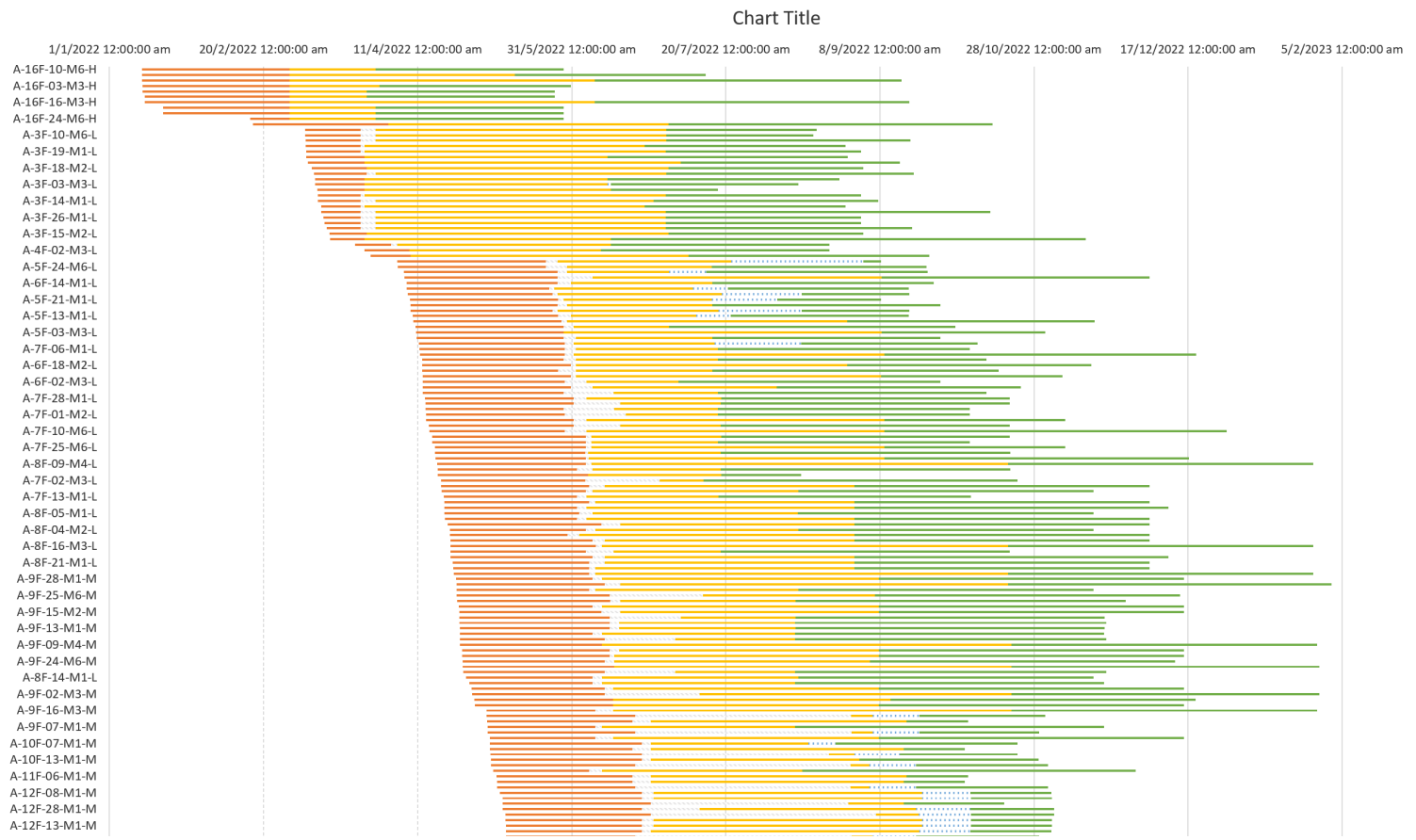
Dashboard



Statics for decision-making

4. Our trilogy (MiC 三寶)

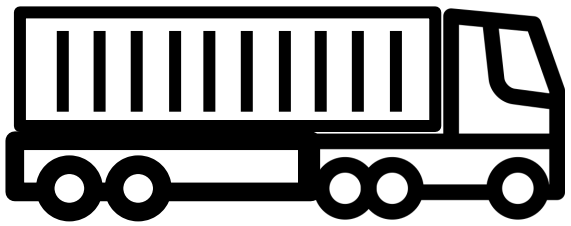
It is used on a daily basis throughout the 40+ steps, all 900 modules!



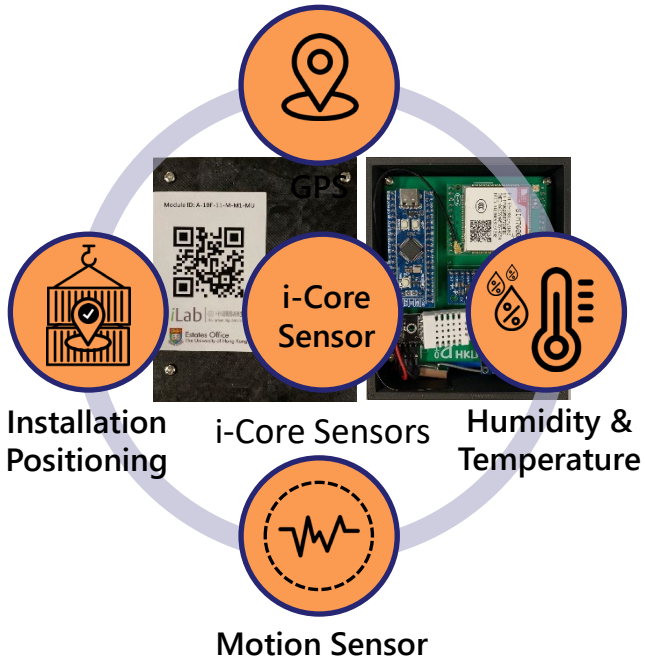
4. Our trilogy (MiC 三寶)

Logistics: *i*-core and blockchain oracle

The **i-Core sensors and smart address systems** are one of the development tools with multi-functions to monitor both the logistics and installation of MiC modules



i-Core sensors and smart address plates are installed in the MiC modules



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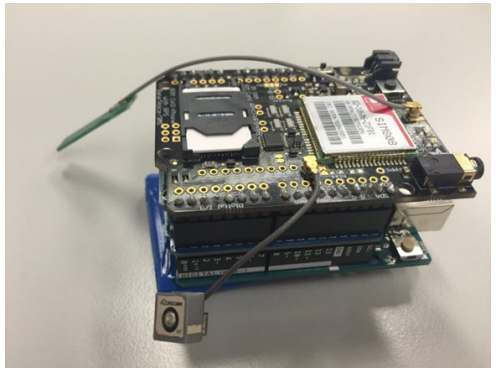
Logistics: *i*-core and blockchain oracle

i-Core sensors are installed in the MiC modules



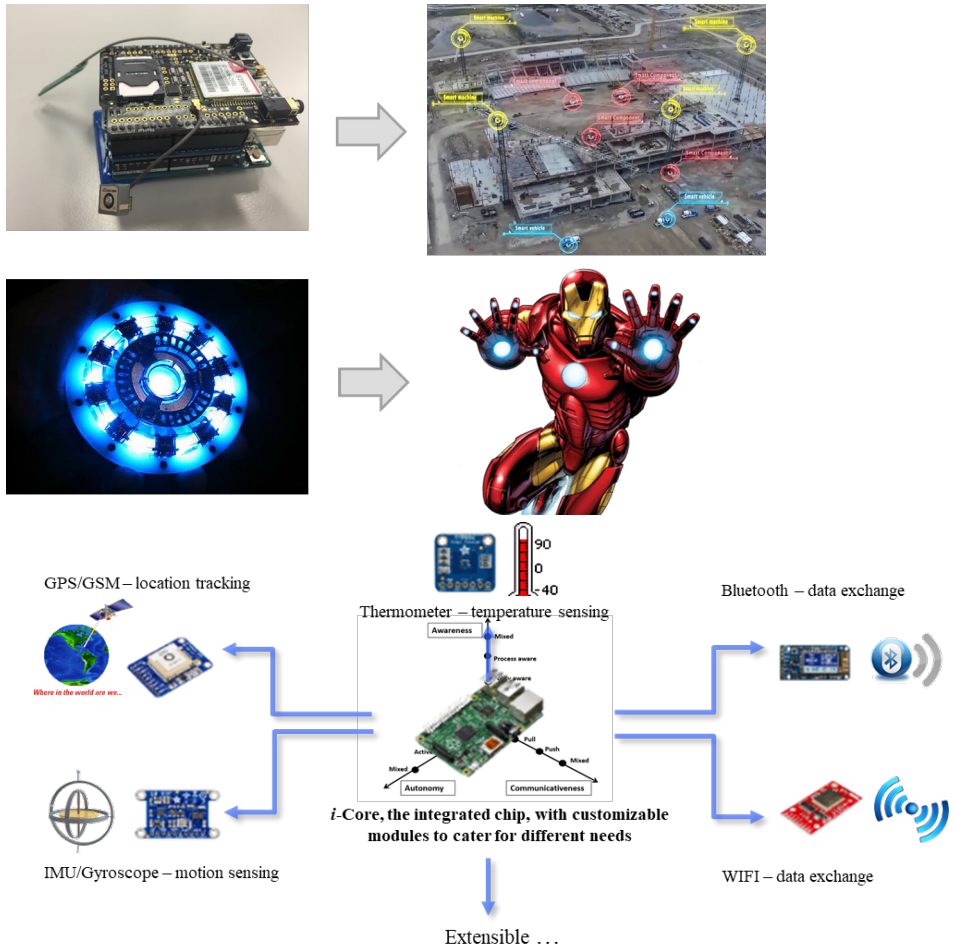
i-core Generation I

i-core Generation II

i-core Generation III

4. Our trilogy (MiC 三寶)

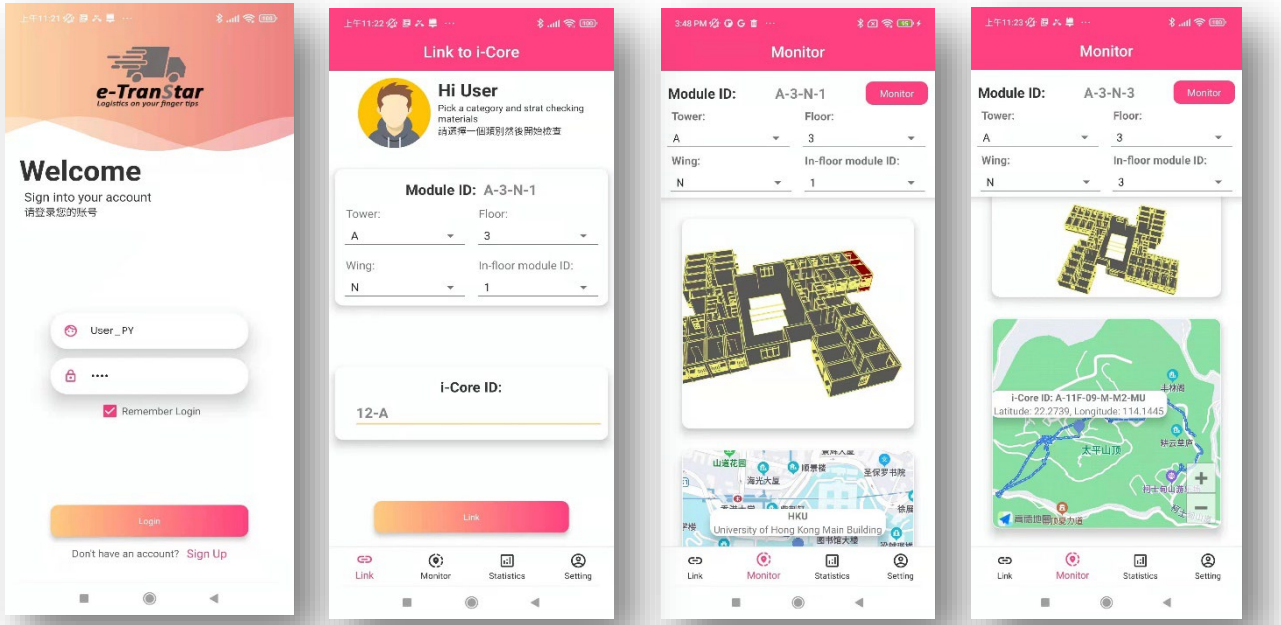
Logistics: *i*-core and blockchain oracle



4. Our trilogy (MiC 三寶)

e-TranStar
Logistics on your finger tips

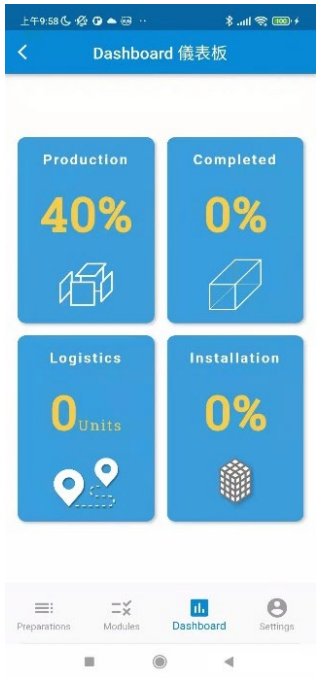
Logistics: app

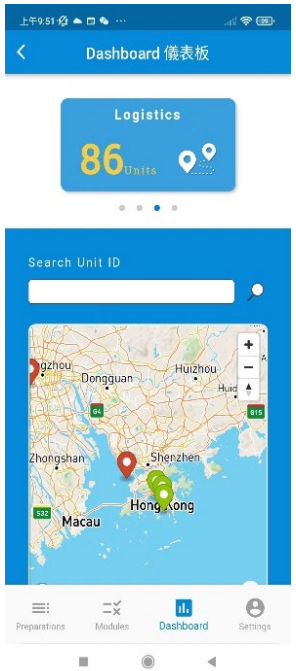


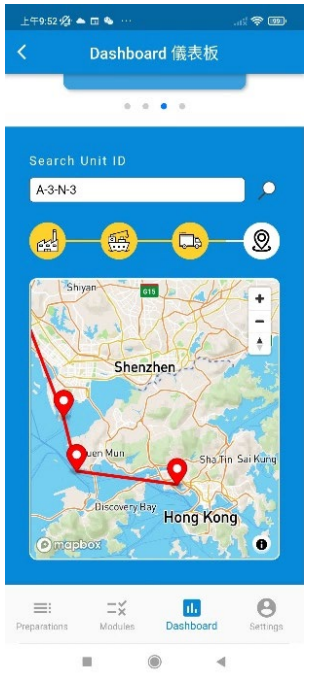
4. Our trilogy (MiC 三寶)

e-TranStar
Logistics on your finger tips

Dashboard

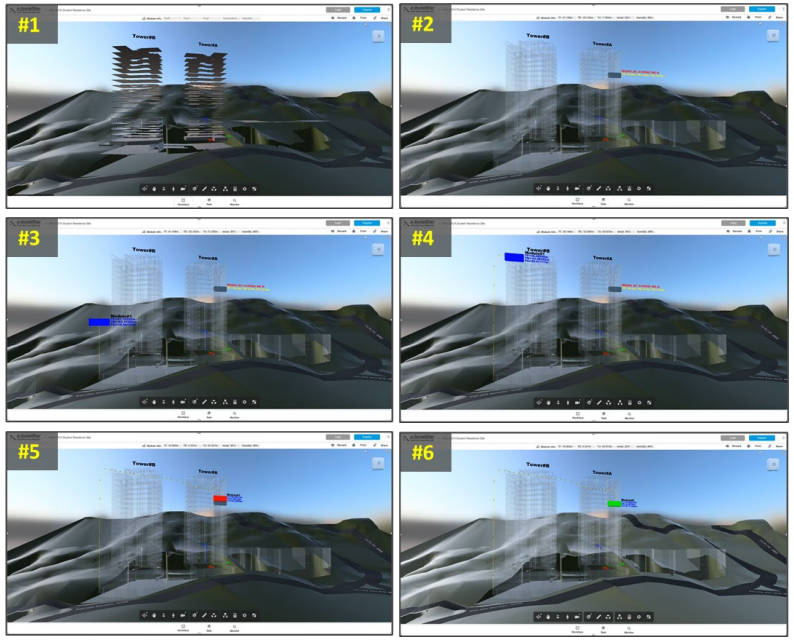




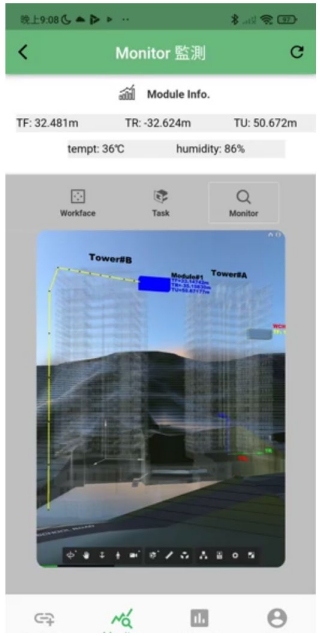


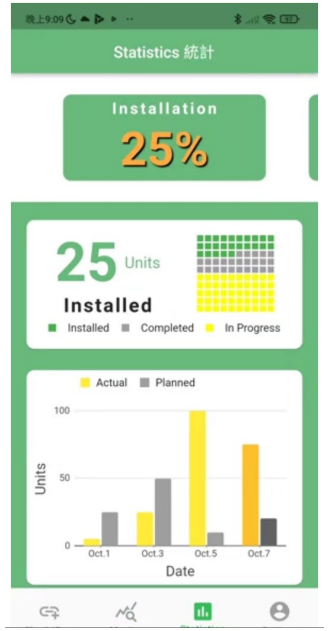
5. Acknowledgement and prospects

Web-base dashboard



App





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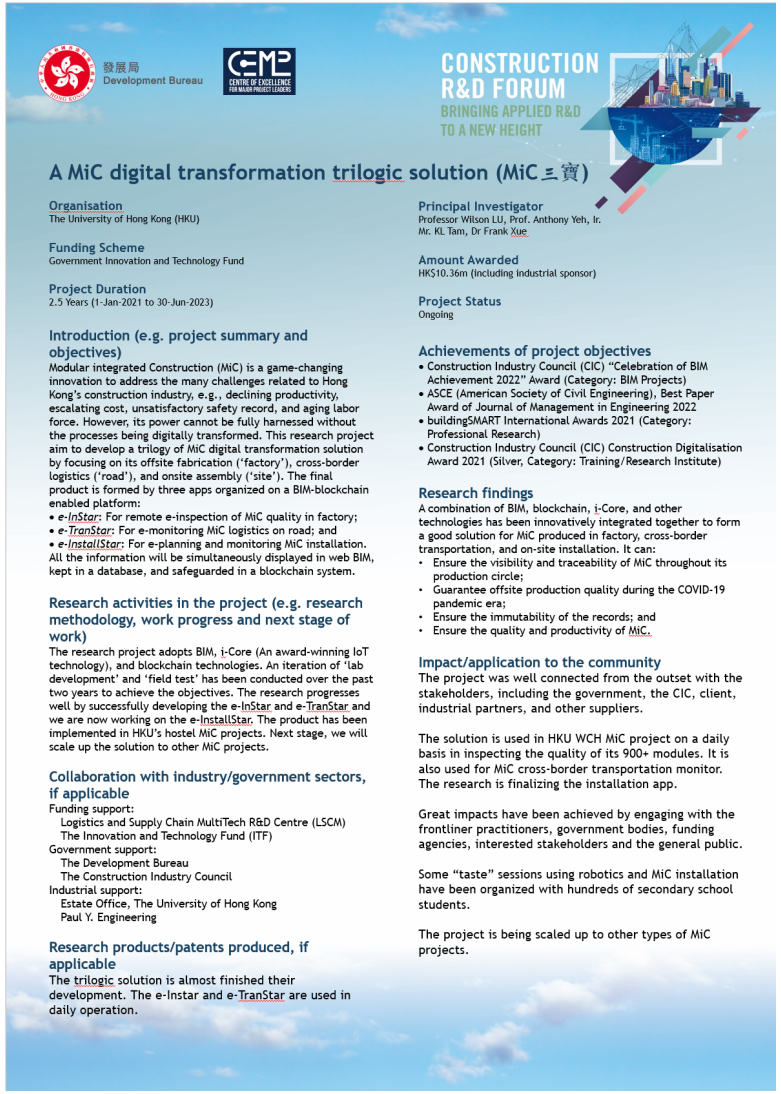


發展局 Development Bureau

CONSTRUCTION R&D FORUM
BRINGING APPLIED R&D TO A NEW HEIGHT

A MiC digital transformation trilogic solution (MiC 三寶)

Organisation
The University of Hong Kong (HKU)

Funding Scheme
Government Innovation and Technology Fund

Project Duration
2.5 Years (1-Jan-2021 to 30-Jun-2023)

Principal Investigator
Professor Wilson LU, Prof. Anthony Yeh, Ir. Mr. KL Tam, Dr Frank Xue

Amount Awarded
HK$10.36m (including industrial sponsor)

Project Status
Ongoing

Introduction (e.g. project summary and objectives)

Modular integrated Construction (MiC) is a game-changing innovation to address the many challenges related to Hong Kong's construction industry, e.g., declining productivity, escalating cost, unsatisfactory safety record, and aging labor force. However, its power cannot be fully harnessed without the processes being digitally transformed. This research project aim to develop a trilogy of MiC digital transformation solution by focusing on its offsite fabrication ('factory'), cross-border logistics ('road'), and onsite assembly ('site'). The final product is formed by three apps organized on a BIM-blockchain enabled platform:

- *e-InStar:* For remote e-inspection of MiC quality in factory;
- *e-TranStar:* For e-monitoring MiC logistics on road; and
- *e-InstallStar:* For e-planning and monitoring MiC installation.

All the information will be simultaneously displayed in web BIM, kept in a database, and safeguarded in a blockchain system.

Research activities in the project (e.g. research methodology, work progress and next stage of work)

The research project adopts BIM, i-Core (An award-winning IoT technology), and blockchain technologies. An iteration of 'lab development' and 'field test' has been conducted over the past two years to achieve the objectives. The research progresses well by successfully developing the e-InStar and e-TranStar and we are now working on the e-InstallStar. The product has been implemented in HKU's hostel MiC projects. Next stage, we will scale up the solution to other MiC projects.

Collaboration with industry/government sectors, if applicable

Funding support:
Logistics and Supply Chain MultiTech R&D Centre (LSCM)
The Innovation and Technology Fund (ITF)
Government support:
The Development Bureau
The Construction Industry Council
Industrial support:
Estate Office, The University of Hong Kong
Paul Y. Engineering

Research products/patents produced, if applicable

The trilogic solution is almost finished their development. The e-Instar and e-TranStar are used in daily operation.

Achievements of project objectives

- Construction Industry Council (CIC) "Celebration of BIM Achievement 2022" Award (Category: BIM Projects)
- ASCE (American Society of Civil Engineering), Best Paper Award of Journal of Management in Engineering 2022
- buildingSMART International Awards 2021 (Category: Professional Research)
- Construction Industry Council (CIC) Construction Digitalisation Award 2021 (Silver, Category: Training/Research Institute)

Research findings

A combination of BIM, blockchain, i-Core, and other technologies has been innovatively integrated together to form a good solution for MiC produced in factory, cross-border transportation, and on-site installation. It can:

- Ensure the visibility and traceability of MiC throughout its production circle;
- Guarantee offsite production quality during the COVID-19 pandemic era;
- Ensure the immutability of the records; and
- Ensure the quality and productivity of MiC.

Impact/application to the community

The project was well connected from the outset with the stakeholders, including the government, the CIC, client, industrial partners, and other suppliers.

The solution is used in HKU WCH MiC project on a daily basis in inspecting the quality of its 900+ modules. It is also used for MiC cross-border transportation monitor. The research is finalizing the installation app.

Great impacts have been achieved by engaging with the frontliner practitioners, government bodies, funding agencies, interested stakeholders and the general public.

Some "taste" sessions using robotics and MiC installation have been organized with hundreds of secondary school students.

The project is being scaled up to other types of MiC projects.

5. Acknowledgement and prospects

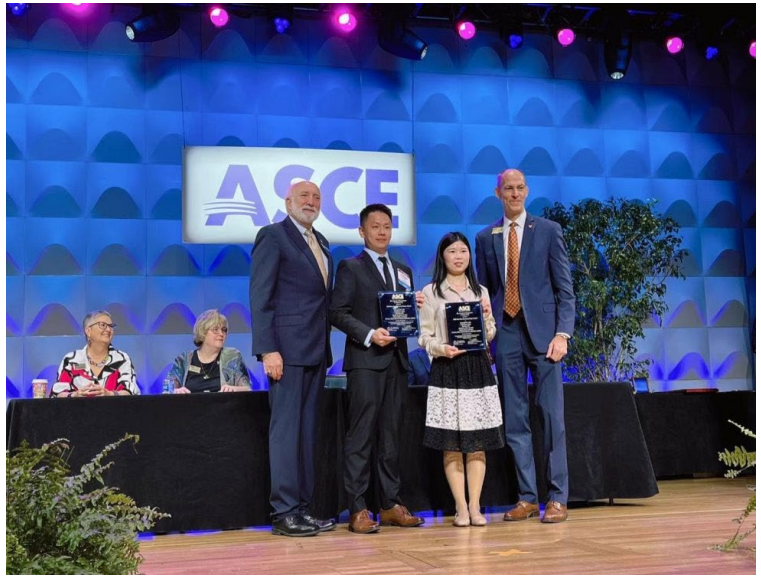
星島網
www.singtao.com

港大遙距電子檢測系統 奪智慧物流金獎

2022-11-18 00:00

港大研發電子檢測系統，跨境遙距監察組裝合成建築模塊的質量，獲香港資訊及通訊科技智慧物流金獎。

5. Acknowledgement and prospects



iLab members Dr Jinying Xu and Mike Wu received the ASCE Journal of Management in Engineering (JME) Best Paper Award 2022 on in California, USA

港大研區塊鏈技術應用於組裝合成工程　獲選土木工程界最佳論文

香港大學建築學院iLab團隊研究人員關於應用區塊鏈技術於

hk.on.cc

港大研區塊鏈技術應用於組裝合成工程　獲選土木工程界最佳論文
https://hk.on.cc/hk/bkn/cnt/news/20221110/bkn-20221110010024365-1110_00822_001.html

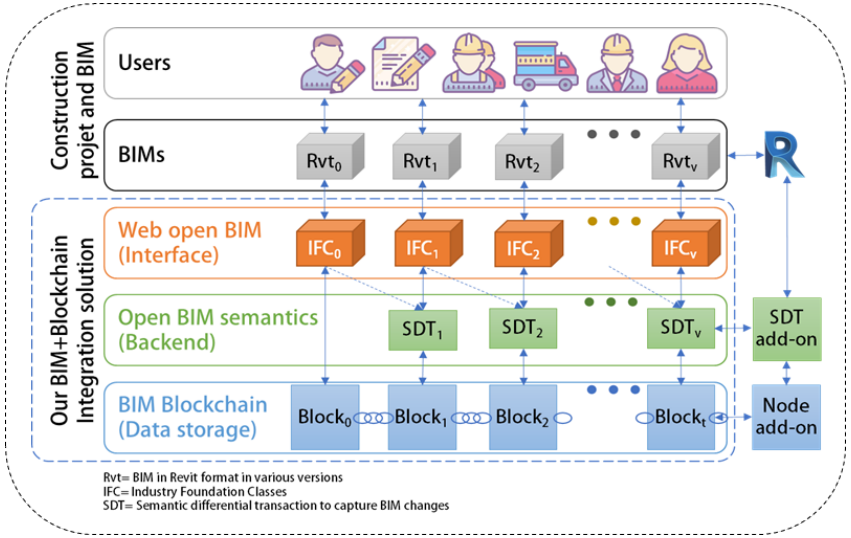
5. Acknowledgement and prospects

HKU Wong Chuk Hang (WCH) project won the the Celebration of BIM Achievement (CBA) in 2022 – 'BIM Project' Category

5. Acknowledgement and prospects

buildingSMART International

OpenBIM and Blockchain integration (OBBi)



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港大研建築信息模型新技術 贏國際大獎賽

2021-10-21 03:23

港大研建築信息模型新技術，贏得國際大獎賽。（前排左起）徐進英博士，呂偉生教授和薛帆博士；（後排左起）吳劉鵬飛和趙銳。受訪者提供。

5. Acknowledgement and prospects

e-instar 2.0: From single project to portfolio; from small to big flats

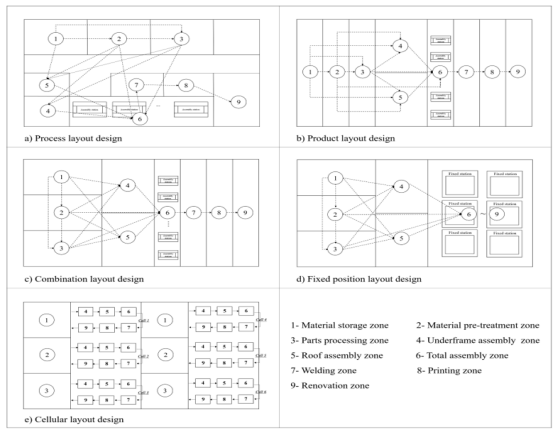
From Wong Chuk Hang to High West

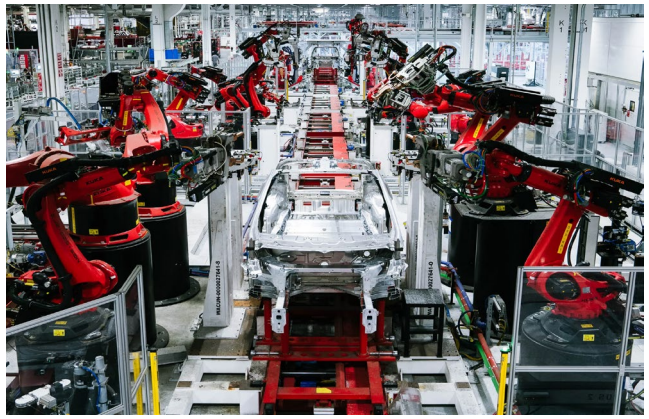
5. Acknowledgement and prospects

Tesla factories for MiC QA/QC, Accreditation

a) A snapshot of a prefabrication factory in the Pearl River Delta (PRD) region of China (Source: authors, 2010)

b) A snapshot of a MC factory in the PRD region of China (Source: authors, 2020)





5. Acknowledgement and prospects

Digital transforming MiC

Digital transformation of modular integrated construction (MiC): Synergizing management theories, construction practices, and digital technologies

THE UNIVERSITY OF HONG KONG 香港大學
faculty of architecture 建築學院
Department of Real Estate and Construction
房地產及建設系

Thank you!