THE HONG KONG POLYTECHNIC UNIVERSITY
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RFID and BIM-Enabled Smart Industrialized Construction

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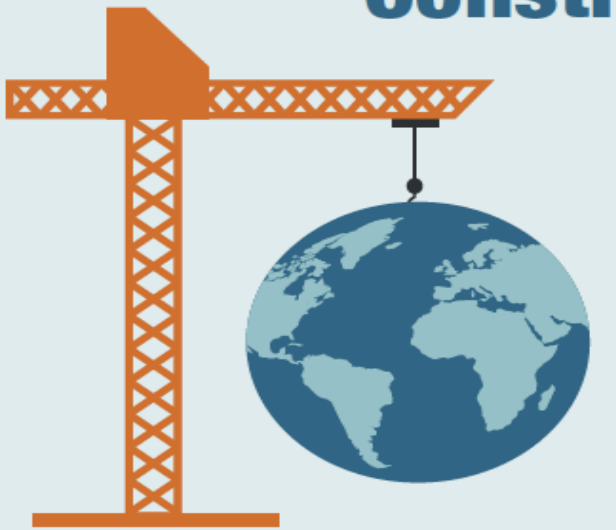
CIB Webinar on 29 June 2021

Construction matters for the world economy

... but has a long record of poor productivity



Construction-related spending accounts for

13% of the world's GDP

...but the sector's annual productivity growth has only increased

1% over the past **20 years**

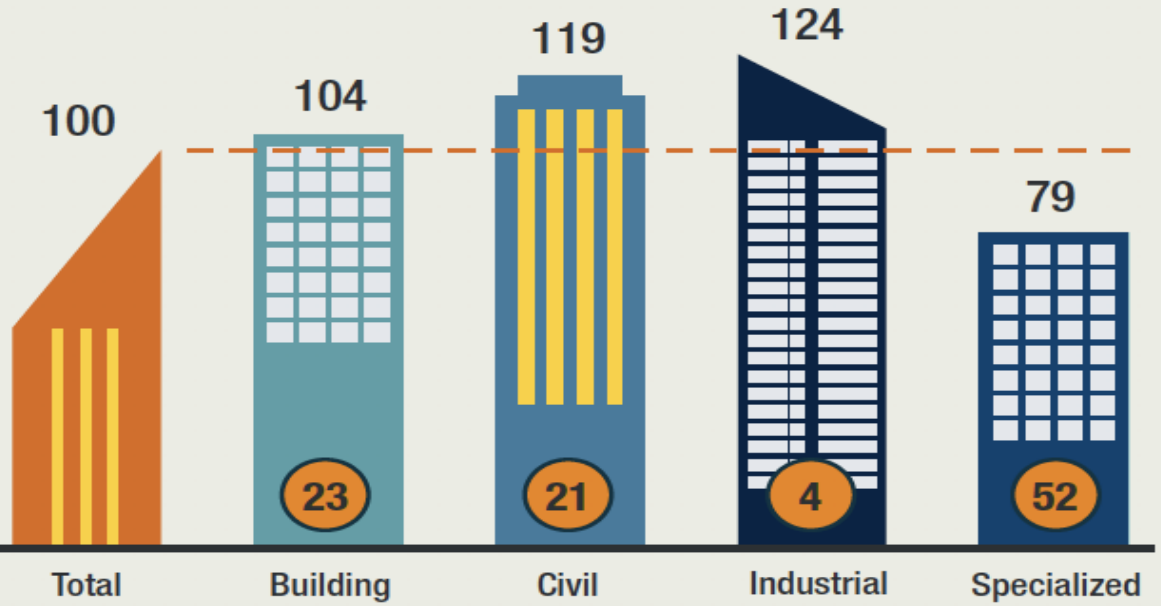
$1.6 trillion **of additional value added** could be created through higher productivity, meeting **half the world's infrastructure need**

Construction is a sector of two halves

Fragmented specialized trades drag down the productivity of the sector as a whole

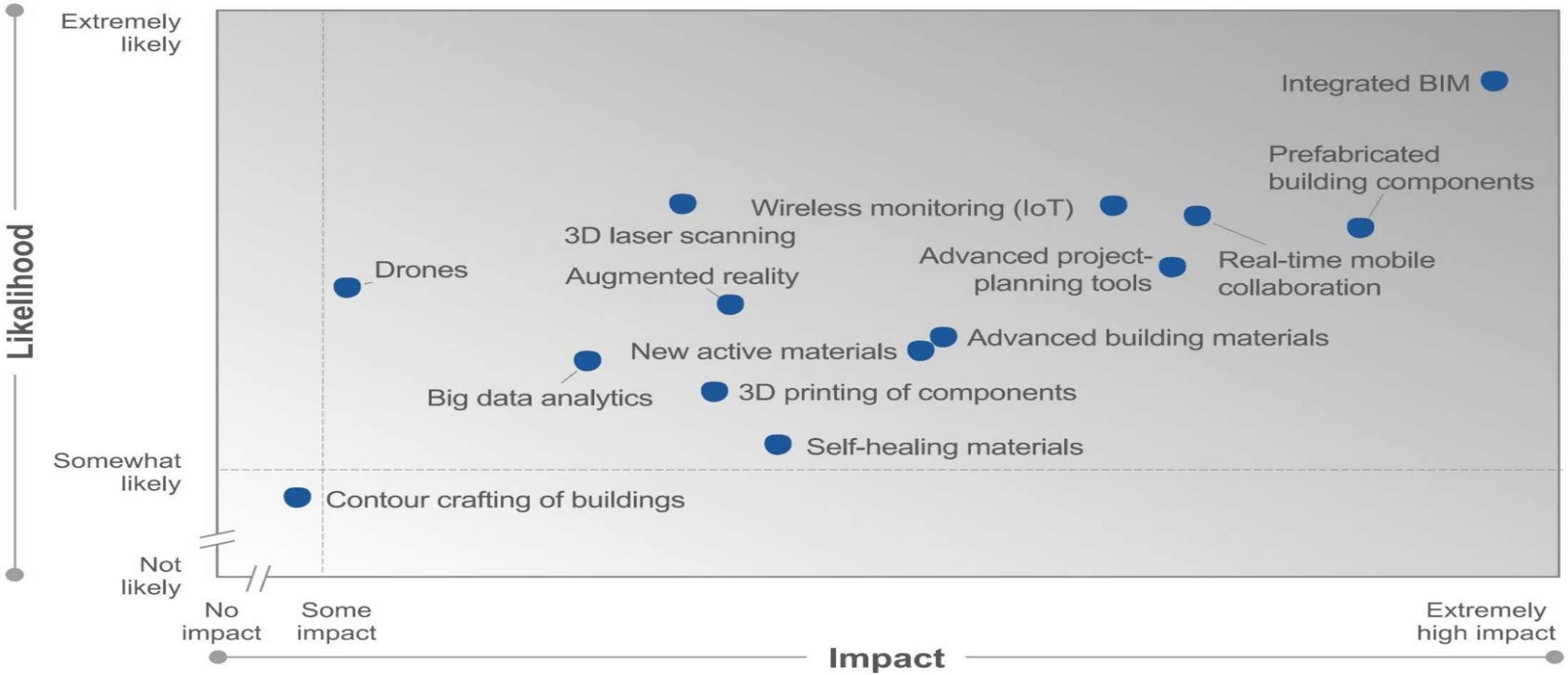
Construction productivity by subsector
Value added per employee, indexed total sector=100, 2013

● % of construction value added



Source: McKinsey & Company, 2017

Impact-likelihood matrix of new technologies



(Shaping the Future of Construction, World Economic Forum 2016)

Our Research on Construction Industrialization

01 We focus on large-scale, complex, and interdisciplinary collaboration in the area of Construction Industrialization by integrating expertise of researchers with diverse professional knowledge and background.

02 National Research Programmes + NSFCs + ITFs + GRFs + PPRs

03 A solid international collaboration with internationally leading research institutions such as University of Cambridge and University of Alberta in this area.

Examples of research projects undertaken

Innovation and Technology Commission: Innovation and Technology Fund + Public Sector Trial Scheme RFID-enabled BIM Platform for Prefabricated Housing Production in Hong Kong

- To help creating smart construction infrastructure where real-time construction data are captured using advanced ubiquitous devices;
- To provide service-oriented decision support systems for facilitating decisions and operations at three key stages of the house construction project lifecycle;
- To provide real-time information traceability, visibility and interoperability tools that integrate and interact with existing information systems

National Basic Research Programme - Ministry of Science and Technology (6.3): National Standards on Critical Technologies for Construction Industrialization

- Comparative analysis of standardization framework among different countries
- Investigation and optimization of the supply chain for Construction Industrialization

National Basic Research Programme - Ministry of Science and Technology (7.1): BIM-based Key Application Technologies For Construction Industrialisation

- To enable effective management of the supply chain in prefabricated housing production
- To facilitate stakeholders to assess and manage the real-time data of a specific building project

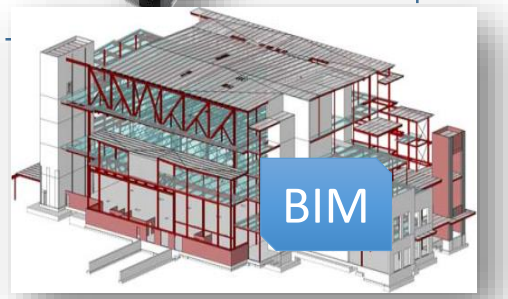
RFID-Enabled BIM Platform for Prefabricated Housing Production in Hong Kong

In collaboration with HKU

Funding Schemes: ITF, PSTS

BIM + IoT + Construction Industrialization

Construction Physical Internet



Problems addressed:

- Coordinate different stakeholders
- Schedule precast in very small site
- Update BIM model with real data
- Avoid misplacement of precast concrete

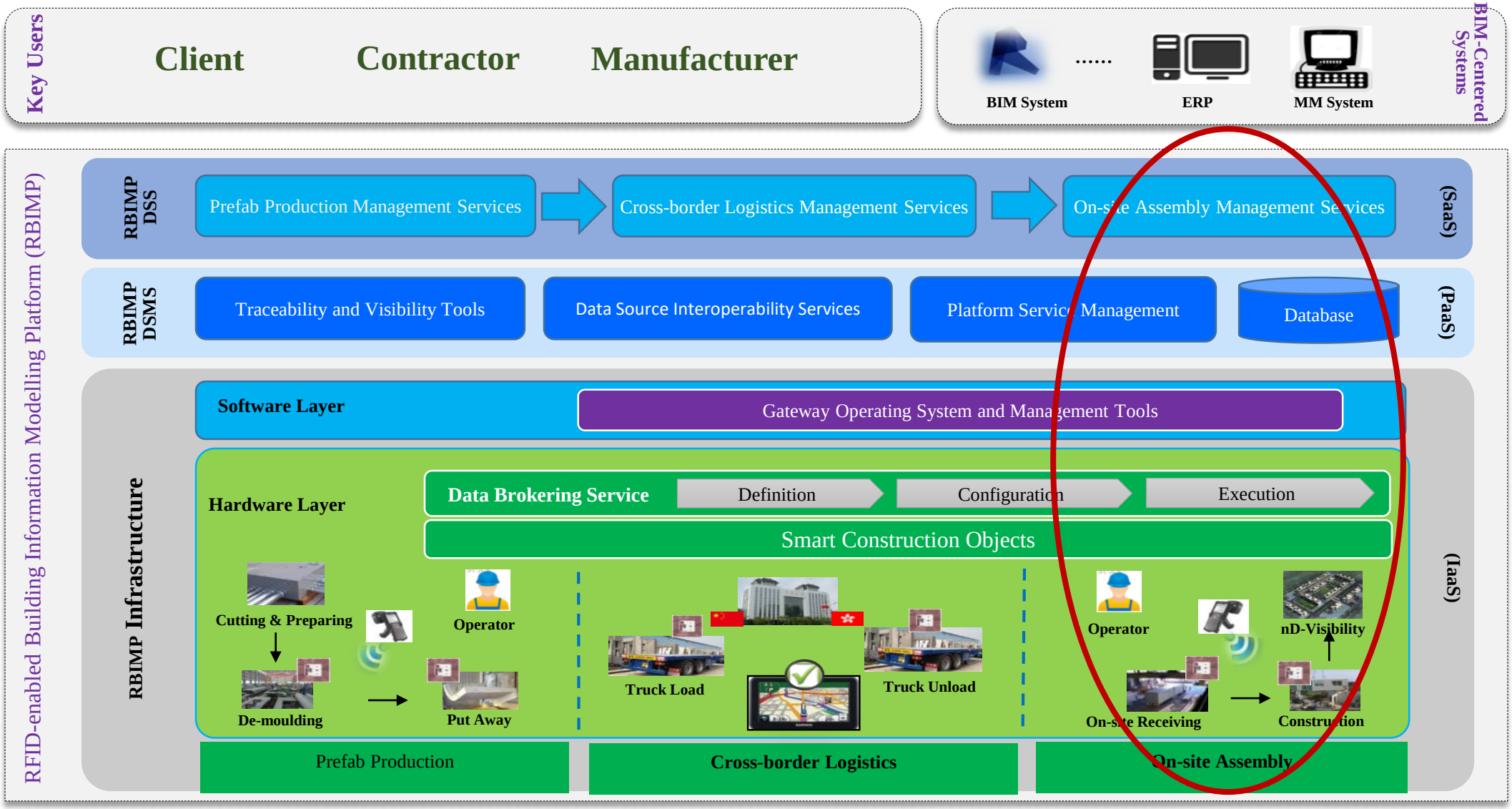
……

The RFID-Enabled BIM Platform

The RFID-enabled BIM platform (RBIMP) aims to develop a **smart and intelligent system** **for enhancing prefabricated housing production.** Benefits of the integrated platform include:

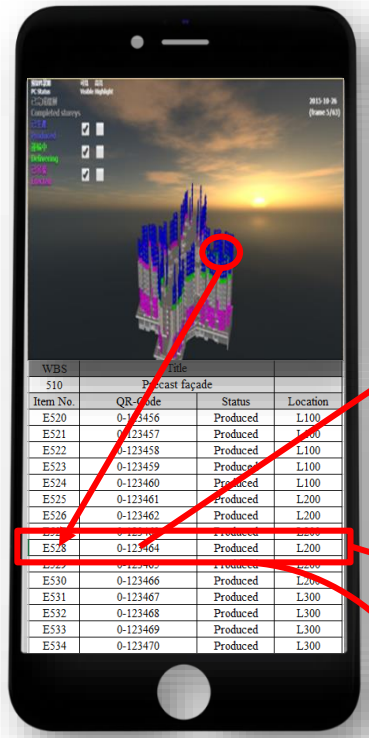
- Seamless communication and coordination among multiple stakeholders through improved information interoperability between processes;
- More efficient cross-border logistics and supply chain management (LSCM) through improved real-time information visibility and traceability;
- Seamless communication and coordination around construction sites to enable a Just-In-Time (JIT) delivery of prefabricated elements to the construction site.

Overview of RBIMP

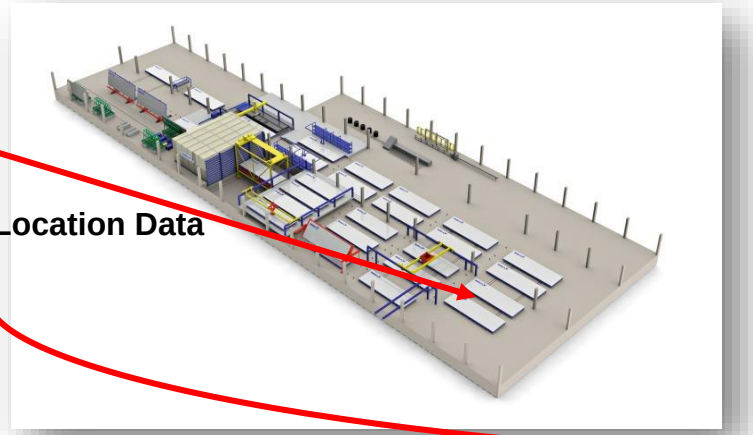


Prefab Production Service

To manage and search prefabricated components from factory, buffer and laydown area in a more prompt and efficient manner by adopting RFID technologies



3D shape & specification data



Location Data

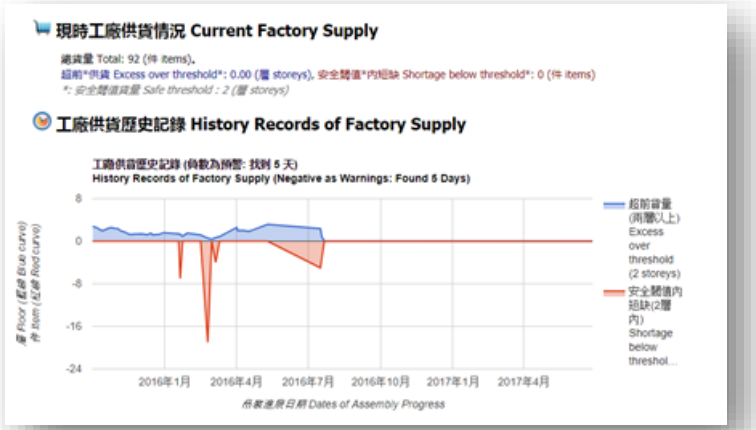
Productivity indicators:

- ❑ Stock management

(e.g. number of precast components/assets being correctly selected, number of precast components/assets being prepared for pickup)

- ❑ Production lead time

(e.g. time to locate precast components and corresponding position, delays in logistics activities waiting for precast components)



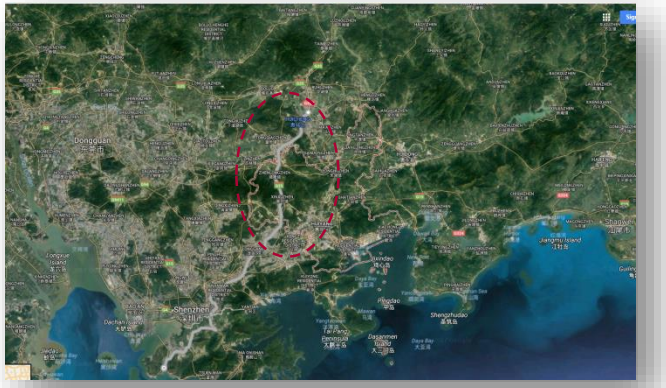
The availability of prefabricated components in factory

Cross-border Logistics Service

To facilitate the prefabricated components to be traced and delivered just in time

(1) Vehicle scheduling and task allocation

(2) Vehicle real-time traceability

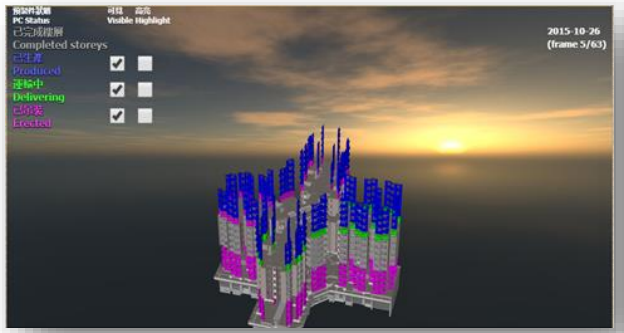


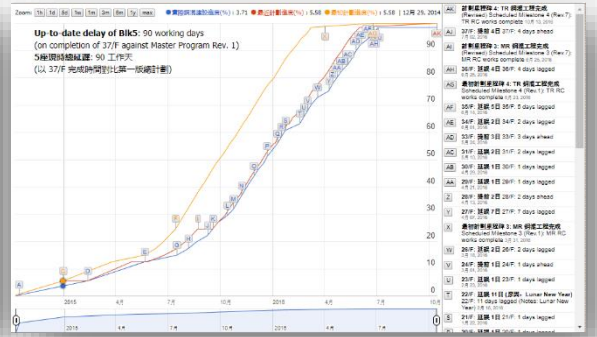
Productivity indicators:

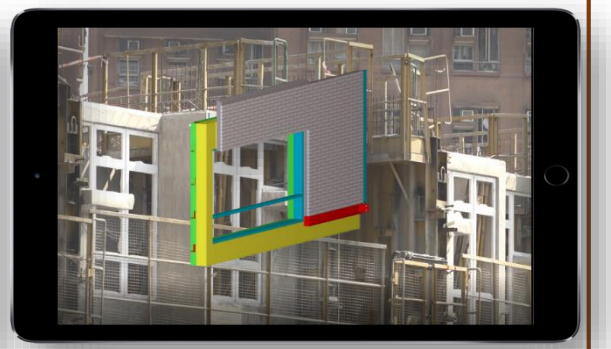
- Vehicle scheduling (e.g. time to arrange truck to arrive in factory/buffer/laydown area, matching truck and trailer)
- Task allocation (e.g. time to allocate the driver)
- Accuracy and frequency of the vehicle tracking

On-site Assembly Service

To integrate the information collected (in production and delivery) to monitor and control the assembly progress precisely for effective time and cost management







Productivity indicators:

- Assembly productivity (e.g. time to assembly each prefabricated component, number of errors in assembly, number of unrepaired prefabricated components
- Efficiency of coordination

Smart Construction Objects

- Capture real-time data of **precast elements**
- Share real-time data among **major stakeholders**

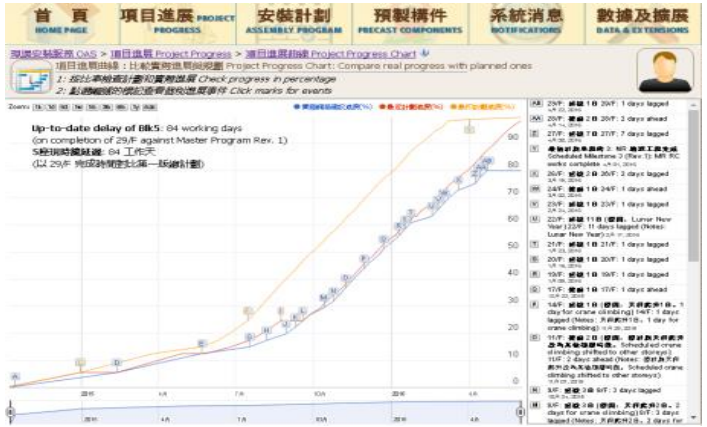
RFID Reader

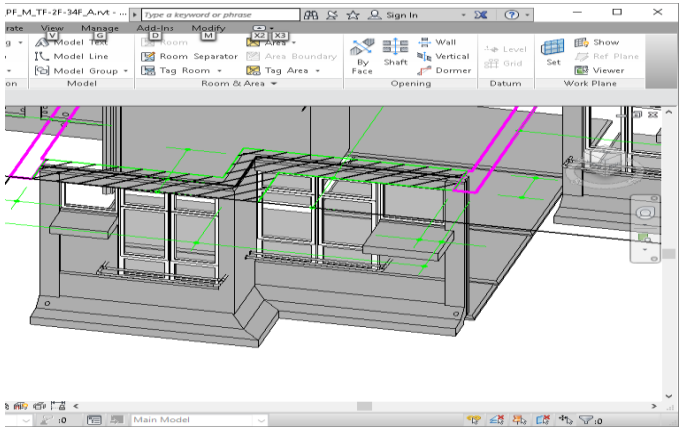
Android Phone with Developed Apps

RFID Tag

Smart Decision Support

- Coordinating orders for **major stakeholders**
- Tracking and monitoring individual components in a real-time manner
- Anticipating problems in **supply chain management**





Implementation of the Platform in Housing Projects

Items	HKHA	HKHS	Description (HS)
Types of precast elements	Precast façade, staircase, semi-precast slab etc.	Prefabricated façade	Only prefabricated façades are incorporated in HS's project
RFID tagging method	Fixed on the reinforcement bar of prefabricated façade	Glued on the interior surface of prefabricated façade	3 in 1 smart tag solutions which include RFID, NFC, and QR code
RFID tagging position	At underneath bottom left-hand-corner of window	At the left-hand of façade, 1200mm above S.F.L.	Tagging position is fixed on the left-hand of façade, 1200mm above S.F.L.
Data capture method	Hand-hold RFID reader	Wearable RFID reader	More convenient and portable compared with the hand-held one
On-site buffer	Large	Small	Two façade yards with small tolerance for schedule delays
Real-time monitoring on-site buffer	N/A	Two types of status: occupied and available	Displayed in different colors to signify the status of buffer
Production cycle time	6-day production cycle	6-day and 4-day production cycle	Production cycle time is supposed to accelerate to 4-day cycle
Real-time progress chart	Master program (RC works)	Installation progress chart and master program (RC works)	Installation progress chart is added into the project progress chart
Visualization in 2D floor plan	4 stages visualization	6 stages visualization	Two stages regarding 'producing' and 'ready to install' are added to the previous system

Summary of highlighted differences between HKHA and HKHS

Site Visits during the Implementation

Benefits to Project Stakeholders

- Receive accurate and reliable information
- Enable efficient cross-border logistics and SCM
- Provide real-time monitoring: alert, alarm, action
- Make continuous improvement to existing process
- Provide seamless communication among stakeholders
- Avoid installation errors, immediate identification of errors

Summary and Conclusions

- Construction industrialization is the future of the construction industry
- More in-depth ground-breaking research is needed in this area
- Established a strong foundation for this special application
- The technology and the platform are getting more mature
- We have accumulated more experience and know-how
- Need customization of the platform for different projects
- Happy to explore possible collaborations with you

Sustainable Construction Lab

- Established in 2008
- Led by Chair Professor in Construction Management
- Focused on Sustainable Construction related research and development
- Supported by various sources of research funding
- Construction industrialization is one of the focus areas
- Established Strategic Focus Area by PolyU
- Strong collaboration with leading universities internationally
- Strong collaboration with industry practitioners as partners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Thank you for your attention!

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