

IoT-Enabled On-site Assembly Service in Prefabricated Public Housing Construction

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Hong Kong Housing Authority
香港房屋委员会



The University of Hong Kong
香港大學



THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

-  1 Background & Opportunity.....●
-  2 Proposed Solution & Progress.....●
-  3 Future Works.....●

1.1 Prefabricated Public Housing Estate Construction (TM A54 S2)

- 3 main phases
 - Production
 - Logistics
 - On-site assembly
- Pros
 - Low pollution
 - Low Cost*
 - Strong architecture
 - Agile teams
 - Win-win
- Cons
 - v.s. labor cost
 - Higher level management

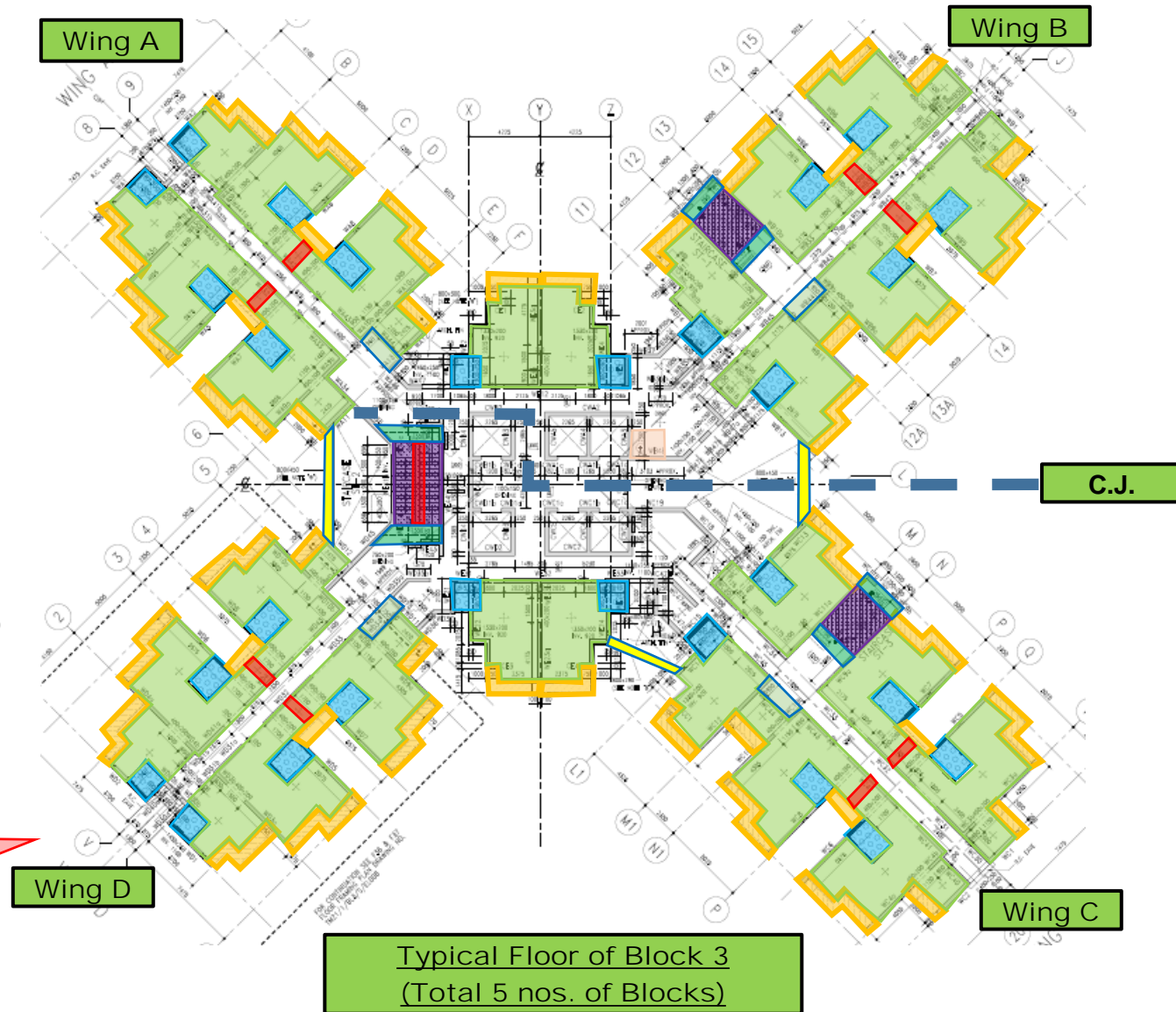


1.2 Work Study for Precast Concrete Elements

Precast Elements Schedule

- Precast Volumetric Bathroom (VPB) (28 nos.)
- Precast Façade (46 nos.)
- Semi-precast Slab (100 nos.)
- Precast Staircase (6nos.)
- Precast Partition Wall (9 nos.)
- Precast Tie Beam (3 nos.)
- Precast Refuse Chute(1 no.)
(Proposed Precast Element)
- Precast Water Cabinet (4 nos.)
(Proposed Precast Element)
- Precast Landing (6 nos.)
(Proposed Precast Element)

Total 203 nos.
Precast Elements
per Typical Floor !!!



Prefabricated components on one typical floor
(Source: Main contractor)



1.2 Work Study for Precast Concrete Elements

Prefabricated components summary (Source: Main contractor)

ElementsName	Block 1		Block 2		Block 3		Block 4		Block 5		Total (All Block)
	Location	Total	Location	Total	Location	Total	Location	Total	Location	Total	
Precast Water Tank	G/F	3	G/F	3	G/F	3	G/F	3	G/F	3	15
Precast Façade	1/F	44	F1-F33	1056	F1-F35	1610	F1-F2	74	F1-F34	1564	7855
	F2-F31	1560			F36-F37	72	F3-F36	1564	F35-F37	111	
	F32	46					F37-F38	72			
	F33-F34	82									
Precast Parapet	Main Roof	52	Main Roof	32	Main Roof	46	Main Roof	46	Main Roof	46	222
Semi-Precast Slab	F2	89	F2-F33	1984	F2-F35	3400	F2	83	F2-F34	3300	15962
	F3-F31	2900			F36-F37	160	F3	83	F35-F37	249	
	F32	92					F4-F36	3300			
	F33-F34	162					F37-F38	160			
Precast Staircase (8 Steps)	F1-F34	134	F1-F33	130	F1-F37	146	F1-F38	150	F1-F37	146	706
Precast Staircase (16 Steps)	F1-F34	68	-	-	F1-F37	74	F1-F38	76	F1-F37	74	292
Precast Refuse Chute	F1-F34	34	F1-F33	33	F1-F37	37	F1-F38	38	F1-F37	37	146
Precast Water Meter Cabinet	F1-F34	136	F1-F33	66	F1-F37	148	F1-F38	152	F1-F37	148	584
Precast Stair Landing	F1-F34	68	-	-	F1-F37	74	F1-F38	76	F1-F37	74	292
Partition Wall (Staircase)	F1-F34	34	-	-	F1-F37	37	F1-F38	38	F1-F37	37	146
Partition Wall (Kitchen)	F2	4	F2-F33	128	F2-F35	272	F2	6	F2-F34	264	1174
	F3-F31	174			F36-F37	12	F3	6	F35-F37	18	
	F32	6					F4-F36	264			
	F33-F34	8					F37-F38	12			
Precast Tie Beam	F2-F34	33	F2-F33	22	F2-F37	36	F2-F38	39	F2-F37	36	166
Precast Bathroom	F2	30	F2-F33	576	F2-F35	952	F2	24	F2-F34	924	4564
	F3-F31	870			F36-F37	44	F3	28	F35-F37	72	
	F32	28					F4-F36	924			
	F33-F34	48					F37-F38	44			

Total = 6705

Total = 4030

Total = 7123

Total = 7262

Total = 7103

Note: Semi-precast slab and precast secondary beam of Commercial Centre Excluded.

Total 32124
Precast Elements



1.2 Work Study for Precast Concrete Elements

The 6-day cycle over four wings (Source: Main contractor)

Tuen Mun Area 54 (J3559) BLK 3 - 6 日 cycle 流水表										
BLK 3 WING		56m³ Concrete Volume		186m³ Concrete Volume		56m³ Concrete Volume		186m³ Concrete Volume		Date: 13-Jun-2014
		DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6			
A	07:00-08:00	上牆紙	08:00-10:00	上門頭磚紙 (A翼及B翼)	08:00-12:00		08:00-10:00	上牆紙 (A翼及B翼) +安裝牆面通氣	13:00-15:00	上門頭磚紙 (A翼+中令)
	10:30-13:00	上牆紙	14:30-15:30	上門頭磚紙		10:00-12:00	上牆紙 (A翼及B翼) +安裝牆面通氣	14:30-15:30	上門頭磚紙 (A翼+中令)	
	11:00-16:30	上牆紙 (A翼+中令)	15:30-16:30	上門頭磚紙		12:00-14:30	上牆紙 (A翼及B翼) +安裝牆面通氣	15:30-18:00	上門頭磚紙 (A翼+中令)	
	16:30-17:30	上牆紙 (A翼+部份中令)	16:30-17:30	上門頭磚紙及門頭磚紙		14:30-15:30	上牆紙 (A翼+中令)			
						15:30-18:00	上牆紙 (A翼+中令)			
B	07:00-8:00	上牆紙	7:00-8:00	上門頭磚紙		13:00-14:30	上牆紙 (B翼及中令) +安裝牆面通氣	07:00-13:00	上門頭磚紙 (B翼+中令)	
	08:00-10:30	上牆紙	8:00-10:00	上門頭磚紙		14:30-16:00	上牆紙 (B翼及中令) +安裝牆面通氣	08:00-18:00	上門頭磚紙 (B翼+中令)	
	08:00-11:00	上牆紙 (B翼+中令)	14:30-15:30	上門頭磚紙及門頭磚紙		16:00-18:30	上牆紙 (B翼+中令)	14:30-15:30	上門頭磚紙 (B翼+中令)	
	11:00-12:00	上牆紙 (B翼+部份中令)	15:30-17:00	上門頭磚紙						
	12:00-16:00	上牆紙 (C翼及B翼)								
C	13:00-14:30	上牆紙 (C翼及B翼) +安裝牆面通氣	07:00-08:00	上門頭磚紙 (C翼及中令)	07:00-13:00	上牆紙 (C翼+中令)	07:00-8:00	上牆紙	7:00-8:00	上門頭磚紙
	14:30-16:00	上牆紙 (C翼及B翼) +安裝牆面通氣	08:00-18:00	上門頭磚紙 (C翼+中令)	13:00-14:00	上牆紙 (C翼+中令)	08:00-10:30	上牆紙 (C翼+中令)	8:00-10:00	上門頭磚紙
	16:00-18:30	上牆紙 (C翼+中令) +上DRY WALL			14:00-15:30	上牆紙 (C翼+中令)	08:00-11:00	上牆紙 (C翼+中令)	14:30-15:30	上門頭磚紙及門頭磚紙
							11:00-12:00	上牆紙 (C翼+部份中令)	15:30-17:00	上門頭磚紙
							13:00-16:00	上牆紙 (C翼及B翼)		
D			08:00-10:00	上門頭磚紙 (A翼) +安裝牆面通氣	13:00-15:00	上牆紙 (D翼+中令)	07:00-08:00	上牆紙	08:00-10:00	上門頭磚紙 (A翼及B翼)
			10:00-12:00	上門頭磚紙及門頭磚紙	14:30-15:30	上牆紙 (D翼+中令)	10:30-13:00	上牆紙 (D翼+中令)	14:30-15:30	上門頭磚紙
			12:00-14:30	上門頭磚紙及門頭磚紙	15:30-18:00	上牆紙 (D翼+中令)	11:00-16:30	上牆紙 (D翼+中令)	15:30-16:30	上門頭磚紙
			14:30-15:30	上門頭磚紙			16:30-17:30	上牆紙 (D翼+部份中令)	16:30-17:30	上門頭磚紙及門頭磚紙
			15:30-18:00	上門頭磚紙 (D翼+中令)						

備註:

使用天秤時間

落石矢時間



落間牆石矢

落樓面石矢

安裝其他預製組件
(陣, 間牆, 垃圾槽, 水標箱)



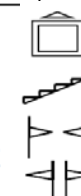
安裝佛沙

扎間牆鉄

扎樓面鉄

安裝預製樓面板

安裝外墙工作臺



安裝預製廁所

安裝預製樓梯

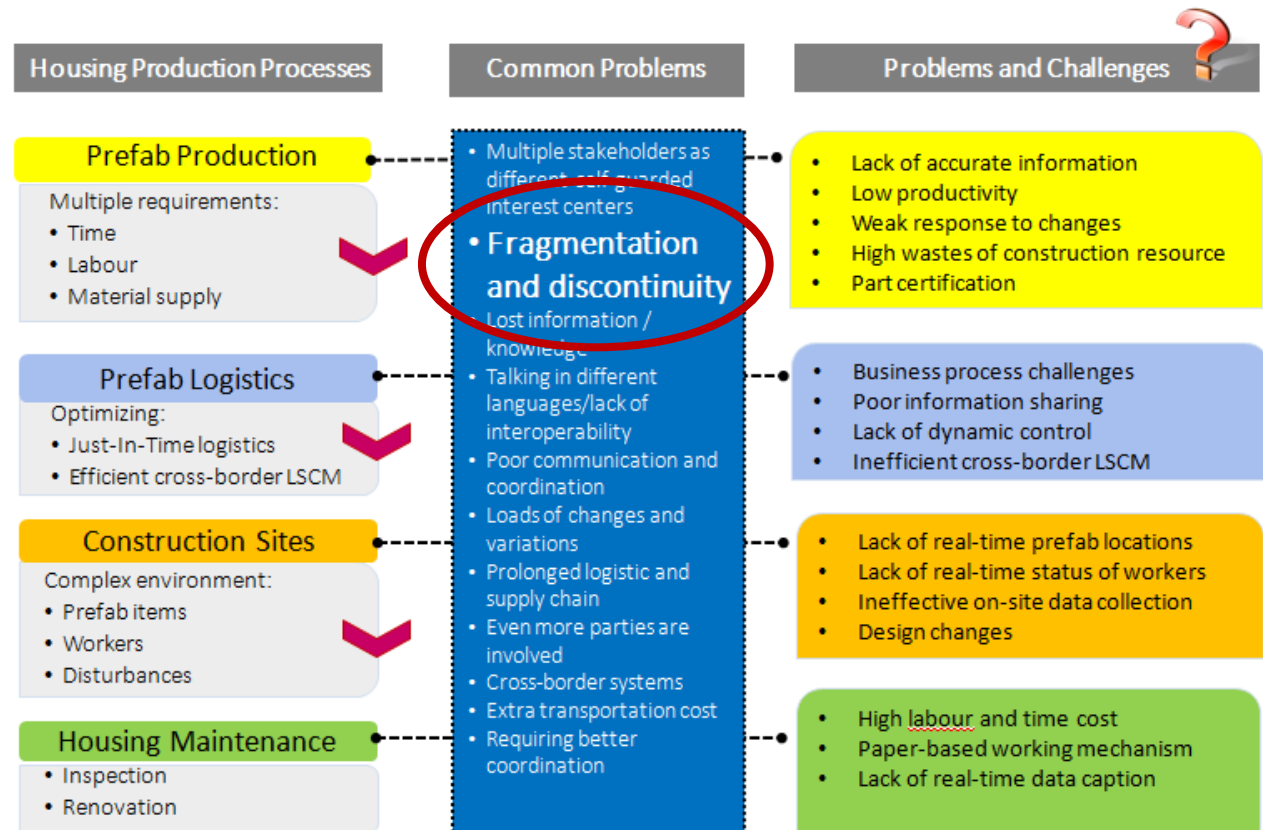
安裝大板模

拆大板模

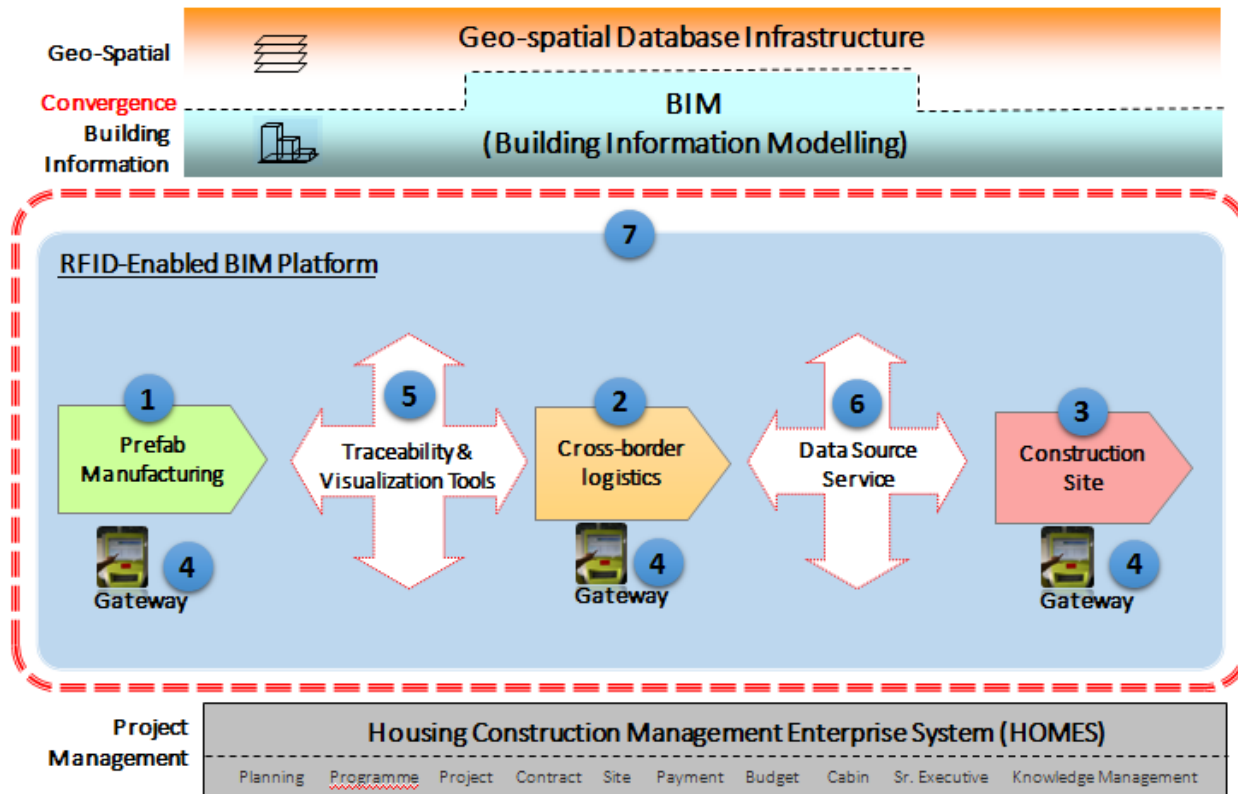


1. 3 Opportunity

- Housing Authority (HA)
 - ~30% Hong Kongers living in its 730k flats
 - One of the leaders in using BIM in HK
 - One of the leaders in using RFID in 2008 (feasibility study); in 2014 (in new proj.)
- Opportunity
 - Increase safety, effectiveness and efficiency
 - A way of increasing productivity
 - Similar problems in private projects



2.1 The Overall Project



- 2 Univ. 4 Dept. 4 Professors
- Many stakeholders
- Add a layer to connect project-based BIM/GIS and ERP/HOMES
- Meets new requirements on automation
- Our team:
 - (3)

2.2 The Technical Solutions (Hard+Soft)

- RFID solution:
 - Plan A: Current solution (offline data)
 - Plan B: Cutting-edge solution (online data)
- Converting n D-BIM:
 - **Revit** → **WebGL 3D** + time (in DB/UI) + cost (in DB/UI)
 - **Volume & location data** → **DB**
- GIS:
 - Only available in Plan B
 - Direction/routing for components (like that in Google Maps)
- Devices & GUI:
 - PC, Tablet, Smart phone, PDA*
 - Web pages, native apps



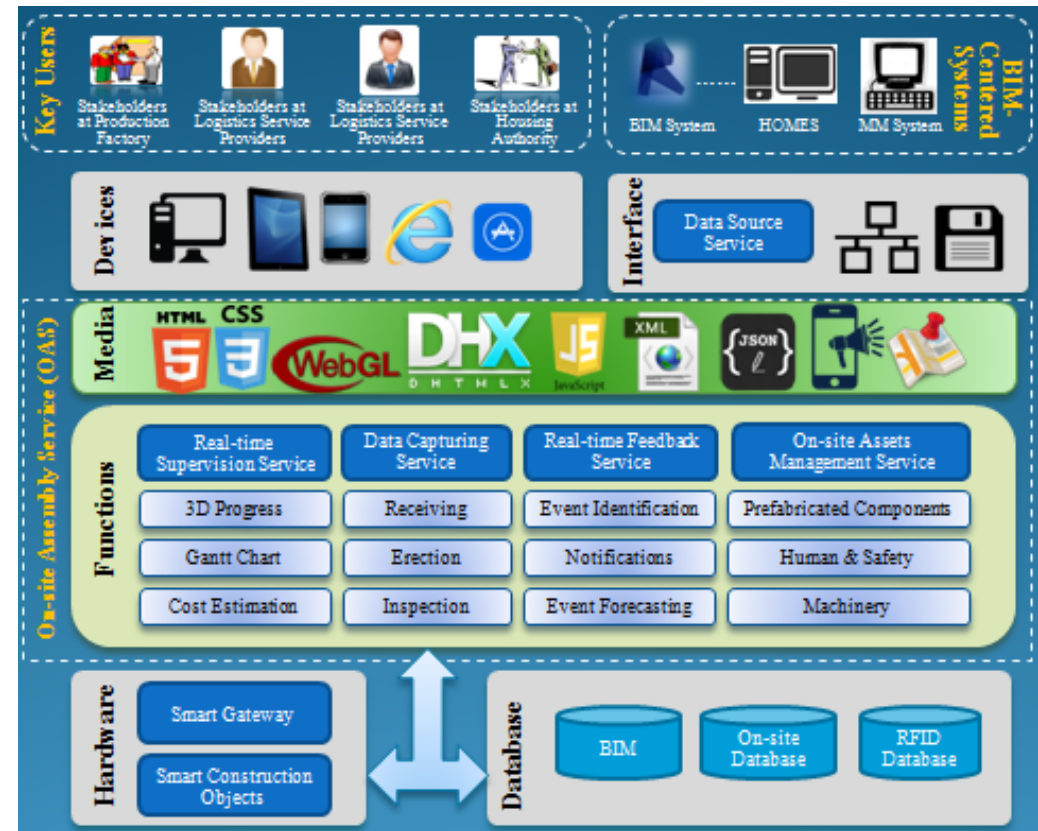
2.3 On-site Assembly Service (OAS): Our Part

- Main users
 - Main contractor
 - Also: HA, other stakeholders
- Hardware/service support
 - HKU
- Data support (partial)
 - Main stakeholders
- Main functions
 - Real-time supervision
 - Data-capturing
 - Real-time (events) feedback
 - On-site assets management



2.4 Progress

- Done:
 - User requirements
 - System architecture
 - Module/Function design
- In Progress
 - UI design
 - Function implementation
- Next a few months
 - Function test
 - Release Alpha test version
 - Construction pilot practice for 1 month

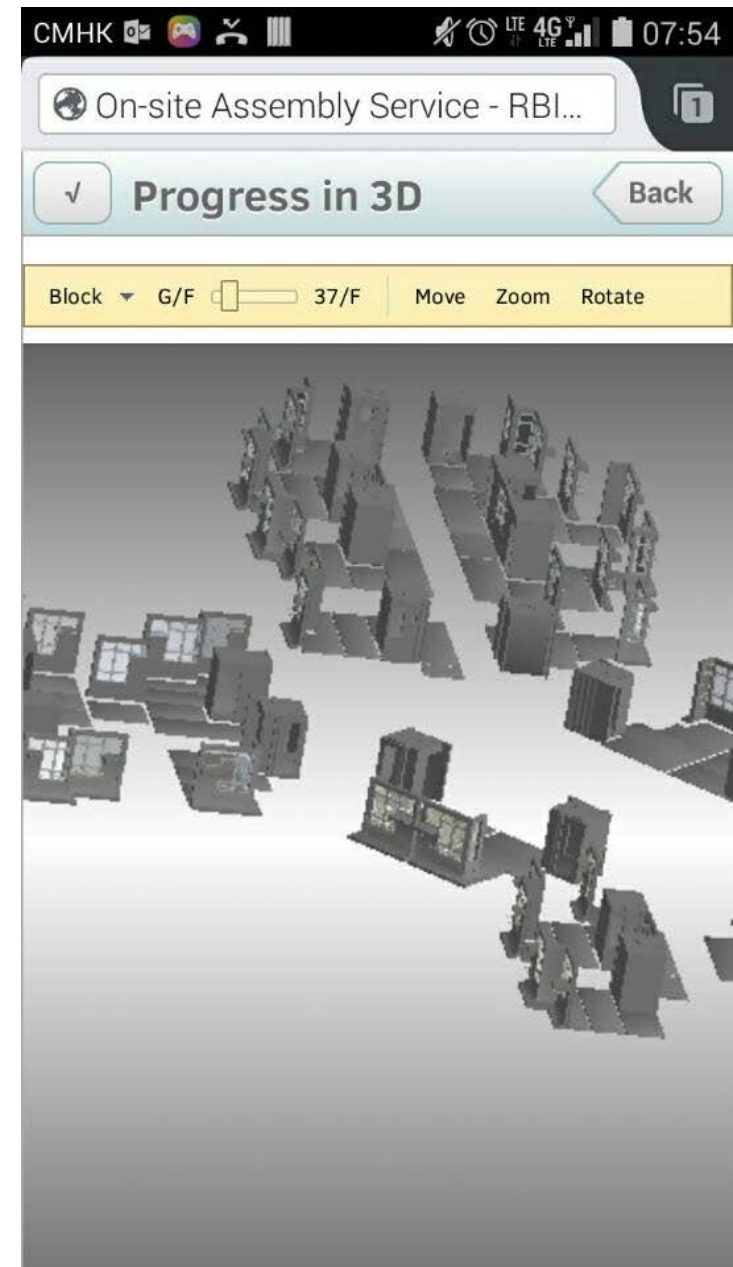


2.4 Visualizing Project Progress on Your Mobile

- On-site users:
 - PDA, Smart phone with RFID functions
- Off-site users:
 - PC, Tablet, Smart phone

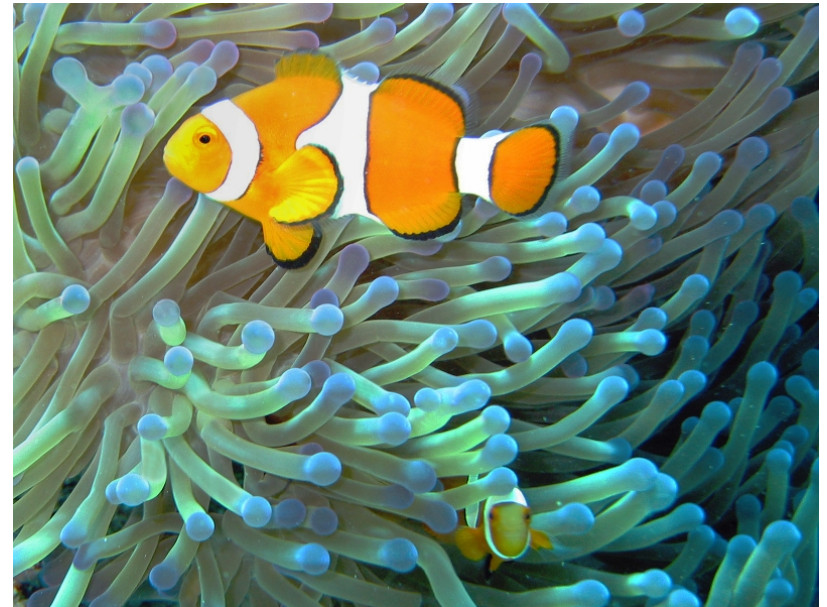


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3. Possible Future Works

- Extending IoTs from construction to operation, maintenance & demolishing
 - Keep data & add more application systems
 - For a digital & smart city
- Extending functions from a single project to the industrial symbiosis network
 - Add value
 - Reduce cost
 - Improve environment



Clownfish feeding on small invertebrates
(from Wikipedia)

THANK YOU



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