Application of BIM and RFID in Public Housing Projects

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(Development & Construction Division)
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1. **Hong Kong Housing Authority**

• The Hong Kong Housing Authority (HA) is a statutory body established in April 1973 under the Hong Kong Housing Ordinance. The Housing Department is HA’s executive arm.

• HA develops and implements a **public housing** programme to meet the housing needs of people who cannot afford private rental housing.

• Approximately **30%** of the Hong Kong **population** is now living in public rental housing units.

• The HA has an existing stock of about **730,000** rental flats.

• We build **79,000** new PRH flats for five years from 2012/13 to 2016/17 and build **100,000** new PRH flats for the five years starting from 2018.

• We build **17,000** new HOS flats for four years from 2016/17 to 2019/20 and thereafter **5,000** new HOS flats a year.
A Sustainable Community

To meet present social, economic and environmental needs but NOT at the expense of future generations.
Use of Information Technology
in Development & Construction Division

- PMS – HOMES
  (Housing Construction Management Enterprise System)
  - Project Management, Contract and Site management
  - Budget and Expenditure, Knowledge Management
- GIS – ESRI for planning, feasibility study, trees management
- CAD – AutoCAD for drafting
- BIM – Revit for design & building information
- PDA – PASS (contractors’ performance assessment) & Site inspection
- RFID – Building components delivery & tracking
- TMS – Time Management System for resource planning
- Discipline’s applications – Design & Analysis
2. BIM Technology in Public Housing Projects

What is BIM?
Building Information Modelling (BIM) is the technology providing a digital 3D environment for carrying out collaborative design and construction planning. The models contain fully parametric components with rich geometric information and properties.

Advantages
1. **Platform** for communication, collaboration and coordination for various designers, builders and facility managers
2. **Single source of information** – consistent and reliable
Use of BIM Technology in Housing Authority

Project Life Cycle

Feasibility studies and Conceptual layout
- Plan & Feasibility Study
  – Design Solution & Modeling
  – Environmental Study
  – Building Performance Validation
  – Documentation & Tender
  – Buildability Study & Clash Resolution

Scheme Design and Project Budget
- Construction Simulation
  – Building materials tracking & monitoring
  – Site inspection
  – Site Safety Planning
  – Logistics & Supply Chain Management
  – Facility Management

Detailed Design and Specification
- Construction of Foundation / Building

Tender
- Facility Management

Documentation
- Quality Control

Completion, Management and Maintenance

Design Options
- Building Design and Performance
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- **Design Options**
- **Scheme Design**
- **Detailed Design**
- **Tender**
- **Construction**
- **Facility Management**

**Building Design and Performances**

**Documentation**

**Quality Control**

**Facility Management**

**Images:**
- Various architectural images and designs highlighting different stages and aspects of building development.
BIM Technology in HA – Current Applications

Creating models for modular flats for design optimization

Assembling building wings and floors

Adding, co-ordinating utilities and services, detecting and resolving clashes

Adding ground floor and roof
BIM Technology in HA – Current Applications

Tong Tau Cottage
Area East – Input from all disciplines

Photomontage of
Exterior View
BIM Technology in HA – Current Applications

Visual Assessment

Daylight Analysis

Sun Shading Study

Airflow & Ventilation Study

Summer condition (SW wind)

Wind goes through the windows and improves the wind condition.
BIM Technology in HA – Current Applications

Optimization of Foundation Design

Excavation and Lateral Support Simulation

Site Safety Planning for Construction, Demolition

Demolition Simulation

- Mass Fill
- Rock Cut
- Footing
BIM Technology in HA – Current Applications

Co-ordinations of Services/Utilities

Design

5D Model to Study Cash Flow

6-Day Typical Floor Construction Cycle
BIM is not just a tool, it brings transformation to construction industry...

BIM Process Shifts the Design Curve*

1. Cost impact of design changes
2. Traditional design process
3. BIM design process

From CEO of HOK
With BIM technology …

we transform ourselves

Organization
Tightly integrated multi-disciplinary team fostering team spirit and collaboration

People
Think ahead. BIM skill. Teamwork, change management

we transform our business

Processes
Upfront design process, re-engineering, office procedures, disciplines practices, industry practices

Partnership
Collaboration among project teams, consultants, contractors and subcontractors, academia
Transformation – Collaboration / Partnership

Collaboration at earlier stage

Scheme Design | Details Design | Final Design & Dwgs.


Architect’s → Arch. Prelim. → Env. Studies → Final Arch

BSE’s Input → Preliminary Arch.’s BIM Model → Detail Coordination

Engg. Studies → Building Services Studies → Final Coordinated Design


Highly Consistent → Coordination by actors

Architect’s Concept
To transform, we developed …

• HA BIM Standard *(pioneered in 2009)*

• HA BIM User Guide

• Localized Libraries

• HA Model Templates

Available on HKHA Website

Benefits in Applying BIM

1. Higher quality of work
2. Saving in construction time
3. Cost saving
4. Environmental friendliness
5. Enhanced site safety
6. Achieving sustainability development
Study on Integration of BIM, HOMES & RFID

GIS (Geo-spatial Database Infrastructure)

BIM (Building Information Modelling)

Design Options  Building Design and Performance  Documentation  Quality Control  Facility Management

Project Life Cycle
- Feasibility studies and Conceptual layout
- Scheme Design and Project Budget
- Detailed Design and Specification
- Tender Evaluation
- Construction of Foundation / Building
- Completion, Management and Maintenance

Housing COnstruction Management Enterprise System (HOMES)
- Planning  Programme  Project  Contract  Site  Payment  Budget  Cabin  Sr. Executive  Knowledge Management

RFID
- Choice of materials
- Site material tracking & monitoring
- Handheld Mobile Device / APP

Enhancement of HOMES: Integration of RFID into HOMES construction module
BIM Technology in HA – R & D

Project Life Cycle

Feasibility Studies and Conceptual Layout

Scheme Design and Project Budge

Detailed Design and Specification

Tender

Construction of Foundation / Building

Completion, Facilities Management & Maintenance

Design Options

Building Design and Performance

Documentation

Quality Control

Facility Management

1. Assist Feasibility Studies

2. Environmental Studies

3. Drawing / BIM Models Integration Approach

4. BIM / Engg. Design and Analysis Software Integration

5. MEP for BSE

6. Integration with Specification

7. ICU Submission

8. Building Code Checking

9. Construction Planning and Site Safety

10. Integration with RFID

11. Facility Management

BIM R&D Items

Design Optimization

Construction Simulation

Life Cycle Management

Design Options

Building Design and Performance

Documentation

Quality Control

Facility Management
Our Goal: To apply BIM to all new projects from design stage by 2014/15

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<th>10/11</th>
<th>11/12</th>
<th>12/13</th>
<th>13/14</th>
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<tr>
<td><strong>Current</strong></td>
<td>12 projects</td>
<td>17 projects</td>
<td>25 projects</td>
<td>21 projects</td>
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<tr>
<td><strong>Annual</strong></td>
<td>~5 projects*</td>
<td>~6 - 8 projects*</td>
<td>~2 - 3 projects*</td>
<td>~2 - 3 projects*</td>
<td>~20+ projects*</td>
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<td><strong>By 14/15</strong></td>
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| **Demand on BIM Skill & Experience** | ![Graph](image)

* The numbers of projects will be subject to adjustment

~1000 nos. (54%) professional + technical + site staff trained
In recognition of our efforts and commitment, HA received -

- HK BIM Awards for four consecutive years 2009 -2012
  2009: Towards Customization with Standard Modular flats in Mass Housing Design
  2010: Transforming the whole Delivery Practice
  2011: Versatile BIM / What You See is What You Can Do
  2012: Pioneering 5D BIM for Quantity Surveying

- Meritorious award for Civil Service Outstanding Service Award Scheme 2011

- HK ICT Award – Silver 2011
3. RFID in Public Housing Projects

Procurement Cycle

HOMES: Housing Construction Enterprise Management System
BIM: Building Information Modelling
RFID: Radio Frequency Identifier
Monitoring Cycle

Upon arrival on site, check in and register using RFID

Data entry

Installation into position

Data entry

Production, inspection and check out at factory using RFID

Data entry

Delivery to site

Database
**RFID System**

- A RFID System comprises
  - **RFID tag** (with a unique identification no.) is an integrated circuit chip with antenna
  - **Reader** is for input or retrieve such data information into or from the tag through radio frequency waves, and to upload it onto a host computer system
  - **Software** in computer system is for such data information processing
(A) RFID in Selected Building Components

(1) Precast Concrete Facade

(2) Aluminium Window

(3) Timber Doorset

(4) Metal Gateset
Benefits of RFID in Building Components

• Excellent traceability ability
  – Assuring components produced in a particular factory have been delivered to a designated site
• Streamlining data management along supply chain
  – Minimizing human errors and efforts
  – Instant data transfer /sharing amongst relevant parties via internet
  – Real time records
• Prevent fraudulent products
• Saving paper and storage space for documents
• Facilitate future maintenance
Building Components at Factory and on Site

- RFID tag embedded inside building components at manufacturing process and register in the Web-Database
- All relevant data, inspection results, reports etc, real-time upload to the Web-Database

Factory

Site

- Logistic Control and verification by RFID Technique
- All relevant data, inspection results, reports etc real-time upload to the Web-Database
(B) Concrete Cubes on Site

Central Database

Embed RFID tag in Cube Making

Input relevant data via RFID scanning and download/upload data to the web page

Delivery to Laboratory
Tag Currently in Use
Concrete Cubes Delivered to Laboratory

Central Database

Cube Registration when arrived at laboratory

Curing

Testing Automatic Data Capturing and Sample Verification by RFID

Test Reports can be printed out immediately, automatically and uploaded to the central database

Scan and register the cube by RFID reader

Automatic measurement on the weight and dimensions of the cube

RFID reader verifies the tag embedded on the cube and monitors the whole testing process
Benefits of RFID in Concrete Cube Testing

• Excellent traceability
  – track the movement of cubes from site to laboratory
• Prevent fraudulent products
  – confirm the same cube is being tested at each step of testing (i.e. weight measurement, dimension measurement, compression test)
• Streamlining data management
  – capture electronically test results and transfer to database for issuance of test reports
• Minimizing human errors and effort
• Paper savings
• Real time records and access to all data via internet
• Improve testing efficiency through automation
(C) Use of RFID in Monitoring C&D Materials Disposal on Site and at Public Fill

Central Database

Record information of the Dump Truck:
• Plate No.
• Total Weight
• Loading Condition
• Chit Form & DDF No.

RFID Scanning

Collection of C&D Materials

Dump Truck arrives the Site

RFID Scanning

Dump truck leaves the site

RFID Scanning

Dump truck arrives the Public Fill

RFID Scanning

Record information of the Dump Truck:
• Plate No.
• Total Weight
• Loading Condition
• Chit Form & DDF No.

Cross-comparison

Reader

Weighbridge

Camera

RFID Tag

Loading Condition

Chit Form

RFID System

Weight Display
Benefits of RFID in Monitoring C&D Materials Disposal in Foundation Projects

- Track movement of dump trucks from site to public fill
- Check and record truck load and view content of C&D materials before leaving site
- Capture details and upload to web-database
- Cross-check with truck load details when truck arrives at the public fill; if information of both stations match, prevention of illegal dumping can be achieved
- The Civil Engineering and Development Department has permitted Housing Authority to install RFID set up at public fill entrance/exit
Type of RFID Tag

• Active type tag
  – Stuck to the windshield of dump truck
  – Readable at a distance of 3m to 3.5m
RFID Reader (active type) installed at the Weighbridge
RFID Recording System at the Guard House

Display of the empty truck weight upon entering site

Display of the loaded truck weight upon leaving site
(Plate No. is recorded in the system by linking with the Tag ID)

Display of the Loading Condition of the empty truck

Scanning of the barcode on CHIT Form and entering into database

Display of the Loading Condition of loaded truck
(photo captured in the system)
CEDD’s Dumping Facilities at Tuen Mun Area 38

3 Entrances and 2 Exits (5 Lanes)

Weighbridge at Entrance
Integration of RFID to HOMES

Information hub on site operations and contract management
Way Forward for RFID Application

• Exploring the viability of applications in other aspects of HA construction
  – Testing: steel bars testing
  – Building components: building components other than the four types of components

• Mass application of RFID in
  – Testing: concrete cube testing
  – C&D materials disposal monitoring for all demolition/piling/building contracts

• Integration with BIM
  – Track data of building components on site and completion of works to facilitate cost planning, payment, cash flow analysis, etc

• Integration with HOMES
  – Capture information in RFID database to migrate to a new module in the HA’s corporate information system (HOMES)
Integrate BIM with Radio Frequency Identification Detection (RFID) to track installation of building components / construction progress.
Integration of HOMES and RFID

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**Design Options**
- Building Design and Performance
- Documentation
- Quality Control
- Facility Management

**Housing CONstruction Management Enterprise System (HOMES)**
- Planning
- Programme
- Project
- Contract
- Site
- Payment
- Budget
- Cabin
- Sr. Executive
- Knowledge Management

Using RFID for contract management and site operation
Housing Construction Management Enterprise Management System (HOMES) provides a common information backbone for the building construction industry. Planning, programme, project, contract and site management, budgeting and payment are fully integrated for ease of information sharing and data exchange amongst all parties.

Other data that can be incorporated into HOMES to enhance project management:

- **Possible Data Source**
  - CAD Drawings / BIM Models
  - Data Captured by RFID
  - PASS (Piling, Building, BSE, LA, etc.)
  - Site Inspection Records captured by Handheld Mobile Devices (with Cloud, GPS technologies)
Conclusion

Technology Brings Changes…

Geotechnical Engineer
Civil Engineer
Structural Engineer

Planning
Architect
Landscape Architect

BIM
RFID
HOMES

Quantity Surveyor
Building Services Engineer

Housing Department
Business Partners
General Public

Public Housing Tenants

Worker
Contractor
Sub-contractor
Supplier
Thank You

We build a Collaborative Future with People, Process and Technology