Use of GIS and BIM in the Development of Public Housing Estates in Hong Kong

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Hong Kong

- Total Population: 7 Million
- Total Land Area: 1,108 sq.km
- Total Residential Area: 89 sq.km (about 8%)
  - Public Housing: 12 sq.km (about 1%)
- No. of Public Housing Estates: 213
- No. of Public Housing Residents: 2 Million (about 30%)
- Average Living Space: 13 sq.m/person

Distribution of Public Housing Estates
Housing Department (HD)

Chief Executive

Secretary for Justice
Secretary for Administration
Financial Secretary

Secretary for the Civil Service
Secretary for Constitutional and Mainland Affairs
Secretary for Education
Secretary for the Environment
Secretary for Food and Health
Secretary for Home Affairs
Secretary for Labour and Welfare
Secretary for Security
Secretary for Transport and Housing

People-centric approach

To help low-income families with housing need to gain access to affordable housing

To provide affordable quality housing, management, maintenance and other housing related services in a proactive and caring manner

Cost-effective and rational use of public resources

Competent, dedicated and performance-oriented team

Core Values
Public Housing Development

(a) Project Life Cycle

- Feasibility Studies and Conceptual Layout
- Scheme Design and Project Budget
- Detailed Design and Specification
- Tender
- Construction of Foundation / Building
- Completion, Management and Maintenance

Project Functions

| Design Options | Building Design and Performance | Documentation | Quality Control | Facility Management |

Architect
Structural Engineer
Building Services Engineer
Quantity Surveyor
Landscape Architect
Civil Engineer
Land Surveyor
Estate Surveyor
Planning Officer
Geotechnical Engineer
plus......
Use of New Technologies in HD

(a) Geographic Information System (GIS)

- History of Evolution

- Desktop Geographic Planning Information System (GPIS) for Planning Studies (2005)
- Web-based 2D GPIS for Planning Studies (2009)
- 3D GIS for Feasibility Studies & Design (2012)
- 3D GIS for Facilities Management (2013)
Use of New Technologies in HD
(a) Geographic Information System (GIS)

• Software

ArcInfo version 10.1

ArcEditor version 10.1

ArcScene version 10.1

ArcGIS Server version 10.1

Use of New Technologies in HD
(b) Building Information Modelling (BIM)

• History of Evolution

1985

Manual Drafting
• Drafting using pen and drawing board
• Time consuming to edit drawings
• 2D drawings may convey ambiguous information

2007

Computer Aided Design
• Drafting using CADD & digital drawings
• Easy to amend
• Coordination by layers
• 2D drawings may convey ambiguous information

2012

BIM Construction & Facility Management
• BIM models carried down stream for construction simulation and site planning
• Also facility management

BIM Modelling & Drafting
• 2D drawings are by product of 3D models
• Easy to revise
• Design and Coordinate in 3D
• Able to carry out analysis and design optimization
Use of New Technologies in HD (b) Building Information Modelling (BIM)

• Software

- Revit (BIM Model)
- ETABS/ ORION (Structural Analysis)
- Solibri (Code Checking)
- Z-print (3D Printing)
- Navisworks (4D Simulation)
- 3D Max (Photo-realistic Rendering)
- Ecotect (Performance Analysis)
- Navisworks (Collision Check)
- Cost X (Material Quantities)
- Civil 3D (3D Topographic Models)
- MEP

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Use of New Technologies in HD (b) Building Information Modelling (BIM)

• Software – Revit

• Spatial Data

Spatial Data in Revit
Use of New Technologies in HD
(b) Building Information Modelling (BIM)

- Software – Revit
- Attribute Data Stored in Relational Database

(c) Integration of GIS and BIM

- Perform 3D Visualization and Animation
- Carry out Analysis
- Streamline Workflow
- Enhance Work Efficiency
- Ensure Consistency of Data
Workflow of Integration of GIS and BIM

• Method 1:
  - Revit
  - Export to IFC Format
  - 3D GIS (CityGML)
  - GeoDatabase (Multipatch)
  - ESRI ArcGIS
  - BIMserver & BIMsurfer (Viewer) with JRE Update 7

• Method 2:
  - Spatial Data in BIM
  - Perform Transformation
  - Export to IFC Format
  - FME / Data Interoperability
  - Convert Spatial Data to Geo-Database
  - ArcGIS
  - Link Attribute Data to Spatial Data

Workflow of Integration of GIS and BIM

• Method 2:
  Final Step: Link Attribute Data to Spatial Data in ArcGIS by Unique Key

Converting Spatial Data

Attribute Data of Revit Database

Link Attribute Data to Spatial Data by the Field ‘Tag’ of Converted Spatial Data and the Field ‘ID’ of Attribute Data in GIS Platform
Workflow of Integration of GIS and BIM

- Method 2:
  Converted Spatial and Attribute Data in ArcGIS

Applications of GIS and BIM in Housing Development

Project Life Cycle

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Contextual Study
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Spatial Planning
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Proposed Buildings

Selected Viewpoint at Shing Mun River, No. 2
Promenade Rest Garden

Scheme 33

Scheme 44

Schemes Design Comparison

Ridge Line Analysis

Project Life Cycle - Feasibility Study and Conceptual Layout

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Geotechnical Study

Legend
- Cut Slope
- Fill Slope
- Retaining Wall
- Barrier Wall
- Platform
- Road
Applications of GIS and BIM in Housing Development

- Proposed Public Housing Development
- Integration of GIS and BIM
- Perform 3D Visualization and Animation in GIS Environment
- Demonstration of
  - Contextual Study
  - Spatial Planning
  - Geotechnical Study

Applications of GIS and BIM in Housing Development

Project Life Cycle

<table>
<thead>
<tr>
<th>Feasibility Studies and Conceptual Layout</th>
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</tr>
</thead>
</table>

Project Functions

- Design Options
- Building Design and Performance
- Documentation
- Quality Control
- Facility Management
Applications of GIS and BIM in Housing Development

From Modular Flats to Block Design in BIM and Visualize the Effect in the GIS Environment

Sun Shading Study from 8:00am – 4:00pm
Applications of GIS and BIM in Housing Development

Detailed Design of Underground Utilities

<table>
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<tr>
<th>Attribute Data in GIS</th>
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<tbody>
<tr>
<td>Type</td>
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<td>Cover_Level_mPD_</td>
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</table>

Checking of Underground Utilities
Applications of GIS and BIM in Housing Development

- Proposed Housing Development and Underground Utilities at Tung Chung
- Integration of GIS and BIM
- Perform 3D Visualization and Animation in GIS Environment
- Demonstration of
  - Contextual Study
  - Geotechnical Study
  - Detailed Design

Applications of GIS and BIM in Housing Development

Project Life Cycle

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Applications of GIS and BIM in Housing Development

Kwai Chung Area 9H

1. Complicated excavation and lateral support system on site
2. 3D model is easier to understand than 2D drawings and written method statements
3. Discussed with site staff and contractor before construction to ensure smooth/safe operations

Site Formation - Excavation, Lateral Support

Applications of GIS and BIM in Housing Development

Safety and Logistic Arrangement for Typical Floor
PRH at Tai Pak Tin Street, Kwai Chung Area 9H

Safety and Logistics Arrangement through Virtual Construction Sequence Model
Applications of GIS and BIM in Housing Development

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Applications of GIS and BIM in Housing Development

View at Each Floor

View at Front End

Zoom in Special Design Features

Prospective Tenants can Visualize the Space before Placing Bids

Applications of GIS and BIM in Housing Development

Building Services Installations
Applications of GIS and BIM in Housing Development

Easy to Retrieve Building Services Installations

Easy to Retrieve the Glass Wall Information from BIM

Applications of GIS and BIM in Housing Development

MEP BIM Model of Shopping Centre
Applications of GIS and BIM in Housing Development

• Estate Management GIS database maintains all the Underground Plumbing and Drainage Records of Public Housing Estates for effective daily facilities management.

• Updating of the records through web-based interface for maintaining the data quality.

Better Visualization

Space Management
Benefits of Using GIS and BIM in Housing Development Projects

1. Effective & Efficient Internal Coordination
   - Better presentation and visualization quality by 3D graphics and animation
   - Provide accurate location of designed structures with real surrounding environment
   - Improve interoperability of various disciplines

2. Effective & Efficient External Coordination
   - Sharing of information among various government departments for improvement of work efficiency
   - Example: Sharing with colleagues of Rating and Valuation Department to carry out visual impact simulation, rates assessment and 3D spatial analysis
Benefits of Using GIS and BIM in Housing Development Projects

3 Higher Quality of Work
- Preserve 3D data
- No data loss
- Enhance consistency, quality and availability of spatial data for interlinked design, construction and maintenance works

4 Sustainability Development
- Avoid duplicated works
- Minimize material wastage
- Simulation of environmental studies facilitates planning and design for sustainable developments

5 Environmental-friendliness
- Accurate design information allows the wider use of standard modular components with quick assembly on site
- Less in-situ works and less waste materials are disposed

6 Better Site Safety Management
- Prior understanding of site conditions
- Locate the accurate position of machinery and utilities
- Visualize virtual construction and walkthrough of the sites at different stages and times

7 Shortened Construction Time
- Construction sequencing can be visualized and studied beforehand
- Work is less likely to be affected by unforeseeable site conditions and inaccurate information

8 Cost Saving
- Reduce construction waste and redundancy of work
- Shorten construction time resulting in cost saving

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Change Management
Transformation Process

Technologies
3D modeling, analysis, 3D printer, RFID, GIS, BIM...

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

Organization
Tighter team formation, multi-disciplinary team, supporting team structure

Partnership
Collaboration among project team, consultants, contractors and subcontractors.

People
BIM skill, think ahead, teamwork, change management, industry practitioners, academia, workforce

Evolution to 3D Matrix Team Structure

Before 1997
- Functional Structure
  - emphasizes more on effectiveness (quality) but less on interdisciplinary co-operation

1997 – 2001
- Matrix Structure
  - emphasizes more on efficiency (managerialism) but the PM teams lack expertise in managing quality

2002 Onward
- 3D-Matrix Team Structure
  - more flexible & adaptive to changing environment
  - everybody is working on one’s own expertise
  - everyone is learning continuously
  - everyone is constantly challenged to do more
  - everyone feels adding value & contributing to the society
Present Situation
HD facilitates the staff to use GIS by
• publishing internal GIS User Manuals including
  • Web Application
  • 3D Analysis
  • Data Maintenance
  • Tree Management Module
  • System Administration

Present Situation
HD promotes the Use BIM to the Public by
• drafting standardization guidelines for implementation of BIM in a systematic way
• publishing BIM documents in homepage including
  • Library Component Design Guide
  • Standards
  • User Guide
  • References
Present Situation
HD promotes BIM to Construction Industry by
• Co-operating and sharing BIM related documents with Hong Kong Institute of Building Information Modelling (HKIBIM)

Building Information Modelling – Provides the HKHA’s in-house Building Information Modelling (BIM) standards, user guide, library component design guide and references.

Homepage of HKIBIM (http://www.hkibim.org/)

The Way Forward
• Widen the applications of BIM and GIS in HD
• Extend data flow from BIM to GIS and vice versa
• Encourage our business partners to use GIS and BIM
• Collaborate with other Government Departments
Conclusions

• HD is constantly exploring new and innovative ways for sustainable development and continuous improvement of public housing to meet the public needs.

• Application of GIS and BIM in housing development
  • provides a much tighter collaboration platform among design teams at an early stage to resolve any design problems, clashes and difficulties.
  • enhances site planning, safety and project delivery.

• Gained valuable experience in the evolution and transformation of technology, organization, processes, people and partnership for review and improvement.