

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

Winnie SHIU, Hong Kong SAR, China

Key words: BIM, GIS, Spatial Data

SUMMARY

The Hong Kong Housing Authority is a statutory body established under the Housing Ordinance in April 1973. The primary goal of the Authority is to help low-income families with housing need to gain access to affordable housing. At present about 30% of the Hong Kong population is living in public rental housing units, and yet the supply cannot meet the growing demand for public housing from the general public.

In order to accelerate and increase the public housing development, there is the need to speed up the various stages of work throughout the project life cycle, starting from feasibility study of potential sites, preliminary design of housing site, detailed design, tendering, construction, maintenance to facilities management. Therefore, advanced technologies, such as, Geographic Information System and Building Information Modelling, have been introduced to streamline and speed up the various stages of development work as far as possible.

This paper will introduce the development of GIS from 2D to 3D and BIM in the Housing Authority: how to make use of these two platforms for speeding up the entire process; how to integrate the two types of datasets including spatial and attribute data, and how to merge them with other types of 3D Spatial Data collected by laser scanning and unmanned aerial system, etc. I will also conclude the paper by highlighting the benefits of using GIS and BIM in the development of public housing.

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

Winnie SHIU, Hong Kong SAR, China

1. DEVELOPMENT OF GIS AND BIM IN HOUSING DEPARTMENT

1.1 GIS

A desktop Geographic Planning Information System (GPIS) was launched in 2005 solely for use by the Planning Officers in the Development and Construction Division (DCD) of Housing Department (HD) on shared basis. The functions of the System are mainly for capturing, storing, integrating, analyzing and displaying the planning and related data, which contains spatial information related to existing public housing estates and proposed housing developments by HD as well as private housing projects and land sale sites.

In view of the versatility and potential benefits of the System, the user-base was extended to other disciplines by migrating from the desktop approach to the web-based interface approach. At the same time the hardware and functionalities of the System were enhanced to comply with the Government's objectives for Data Alignment Measures¹ on the exchange of Planning, Lands and Public Works Data. The Pilot web-based GPIS was launched in 2009.

With more usages being made of the GIS, benefits of the System had become more apparent and it was anticipated that more benefits could be generated from more applications in the other disciplines. Therefore, in 2012, the system was upgraded to cater for 100 concurrent users. The System was further enhanced to enable users to carry out different types of analysis during the project life cycle of public housing sites in the 3D environment. A GIS for Estate Management Division (EMD) was further launched in 2013 so as to continuously update the facilities information provided by DCD during the maintenance period for supporting the facilities management.

¹ In 2003, the Housing, Planning and Lands Bureau of Hong Kong Government commissioned the consultancy study on "Implementation of Data Alignment Measures (DAM) for the Alignment of Planning, Lands and Public Works Data" to take forward the implementation of DAM. The data includes geographic data, Computer Aided Drawing data and textual data. The consultancy study was completed in March 2004 and departments concerned agreed to proceed with the implementation of six DAM solutions, including DAM 1: Common Spatial Units; DAM 2: Symbology for graphic entities; DAM 3: Standards on the file formats for exchanging data; DAM 4: Policy on exchange of data in electronic form; DAM 5: Metadata catalogue service and DAM 6: Metadata production tools. Data under DAM 1 which includes Slope, Building, Lot, Road Centreline and Tertiary Planning Units/Street Blocks (TPU/SB) is now available for sharing among government departments.

1.2 BIM

Before the implementation of BIM, HD used to designing the layout of an estate using 2D software, which made it difficult to visualize the various relationships in a 3D context, such as the topography and surrounding buildings. HD then switched from manual drafting of design drawings to mainframe CADAM, as the first Computer Aided Drafting tool in 1985. However, since mainframe computer was very expensive in those days, staff had to use just a few workstations on shared basis. In year 2000, HD migrated from CADAM to AutoCAD and each staff was provided with their own CAD workstations. Higher productivity was then achieved.

HD was among the first government departments in Hong Kong to experiment with BIM. HD's experiments with BIM began with the design aspect of its projects in 2007. The first trial was the formation works for one of the HD's projects involving three platforms on a hillside that proved to be too complex for 2D. As 3D coordination was important, HD decided to use BIM for the project's planning and design and the result was found positive. Thereafter, from the use of BIM for design, HD gradually moved to use it for construction as well since 2012. Having tested three different BIM software suites on five projects, this process has been applied to more projects later on. HD currently has 21 BIM projects, of which five are at the design stage and 11 are at the construction stage, whereas the remaining ones are at tendering and completion stage.

Since the implementation of BIM in 2011, the visualization of 3D design model has become handy and the work flow procedures have been streamlined for improvement of work efficiency. HD aimus at implementing BIM in all construction projects in 2015.

2. HOUSING DEVELOPMENT PROJECT LIFE CYCLE

To construct a public housing estate from bare ground to occupation by tenants, the typical project life cycle is, in sequence: (i) feasibility study and conceptual layout; (ii) scheme design and project budget; (iii) detailed design and specification; (iv) tendering; (v) construction, and (vi) management and maintenance. Please refer to Figure 1 below.

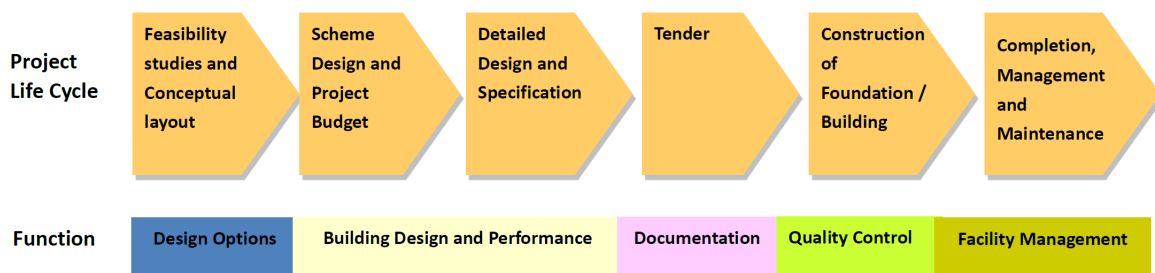


Figure 1. Typical Housing Project Life Cycle of HD

2.1 Feasibility Study and Conceptual Layout Stage

In the feasibility study and conceptual layout stage, a project team consisting of various works professionals will undertake a wide range of technical studies and assessments to ascertain the suitability and feasibility of each site for public housing development. These are essential parts of the integrated planning and design process for public housing developments. The resultant draft planning briefs are used to seek agreement from Government bureaux and departments, and for consultation with local communities and District Councils. The planning briefs are approved by the Planning Department's District Planning Conference in the respective districts. The technical studies include architectural feasibility study, planning and visual assessments, civil engineering feasibility study, traffic impact assessment, sewerage/drainage impact assessment, environmental assessment, geotechnical feasibility study, air ventilation assessment, visual impact assessment and other technical studies as required.

2.2 Scheme Design and Project Budget Stage

In the scheme design and project budget stage, the project team will develop the approved layout and approved development parameters into a fully worked-up scheme design and estimate the project construction cost ceiling for financial approval accordingly.

2.3 Detailed Design and Specification Stage

In the detailed design and specification stage, the project team collates all planning, construction and client's requirements and prepare the detailed design proposal based on the approved scheme design.

2.4 From Tendering Stage to Maintenance

After completing the tendering procedures, the construction stage, namely, foundation and superstructure will commence. In some complex projects, much work is involved in the demolition of old structures, decontamination of land and site formation. After the basic completion of the construction, the public housing estate will be handed over to the estate management staff of HD to follow up with maintenance and remedy of minor construction defects.

2.5 Advance Completion of Housing Projects

In order to advance the completion of a public housing estate, HD has formulated strategies to shorten the life cycle from the very beginning stage to the detailed design and specification stage from 3 years to 1 year, by streamlining and enhancing the existing workflow. Among the various measures, the use of information technologies, such as GIS and BIM, has been proved enhancing the efficiency of the project team. Various applications of GIS and BIM throughout the project life cycle are introduced in Session 4.

3. INTRA-DEPARTMENT AND INTER-DEPARTMENT COMMUNICATION

Within HD, each and every project is implemented through the collective efforts of professional, technical and site teams. A large group of works professionals are involved, such as, architect, building services engineer, civil engineer, geotechnical engineer, land surveyor, landscape architect, planning officer, quantity surveyor, structural engineer, and so on, to provide multi-disciplinary “through-train” services covering all aspects of public housing development from site search, planning, design, tender, and construction to redevelopment.

In the early stages of the development of a public housing estate, HD maintains a close contact with other government departments. For example, HD would clarify the estate site boundary and site possession dates with the Lands Department to ensure the site is available in time to meet the project programme. Consent from Planning Department have to be sought for the permissible development parameters. Comments on individual professional issues have also to be sought from other departments like Civil Engineering and Development Department, Highways Department, Drainage Services Department, Water Supplies Department, Environmental Protection Department, Fire Services Department, etc. Moreover, the District Councils concerned have to be consulted to gain their support on the proposed public housing development.

It is generally recognised that the availability of GIS and BIM has enhanced the intra- and inter-departmental communication. Inside HD, each project team member can visualise the professional input of each other through the graphical presentation of the various components of the development in GIS and BIM environment. Counterparts in other government departments can also grasp easily the architectural and engineering details of the housing project with the aid of fully integrated GIS and BIM data. Members of the public and statutory bodies can also easily appreciate the housing project, in relation to the surrounding environment.

4. APPLICATIONS OF GIS AND BIM IN THE PROJECT LIFE CYCLE

The presentation of 3D terrain and building model requires different spatial data types, including orthophotos, terrain models, vector based 2D and 3D objects and object textures. These different types of data have different characteristics and requirements in terms of creation, management and visualisation. For other design models including building and utilities, these are created in BIM environment. For the integration and visualisation of different types of spatial data with the design models, GIS is involved.

4.1 Feasibility Study and Conceptual Layout Stage

At the feasibility study and conceptual layout stage, the project teams carry out a contextual study using GIS to obtain an overview of the project in the adjoining environment. The existing buildings in 3D, terrain surface, orthophoto images and the preliminary design models are imported to the GIS platform for the study. For further enhancement of the design scheme, the project teams utilise the GIS functions for spatial planning work in their

preliminary layout design taking into consideration the surrounding structures and terrain. The integration and visualisation capabilities of the GIS enhances the efficiency of the design process and quality of the design. Different professionals can visualise the conceptual layout design in the common 3D environment and provide direct feedbacks for the refinement of the design.

In those cases which require planning approval from the Planning Department regarding height and disposition of buildings, the ridge line analysis provides an effective tool for the project team to arrive at an optimum layout and height of the proposed building blocks so as to maximise the gross floor area as well as to blend in with the surrounding environment. (Figure 2)



Figure 2. Contextual Study (Left) and Spatial Planning (Right)

4.2 Scheme Design and Project Budget Stage

In the scheme design and project budget stage, not only the scheme design of the proposed development is involved, the interfacing with existing utilities is required. To enable a more comprehensive study, utilities records from various government departments and utilities companies are collected and converted to the GIS environment for checking against the proposed design in both spatial and attribute aspects. (Figure 3)

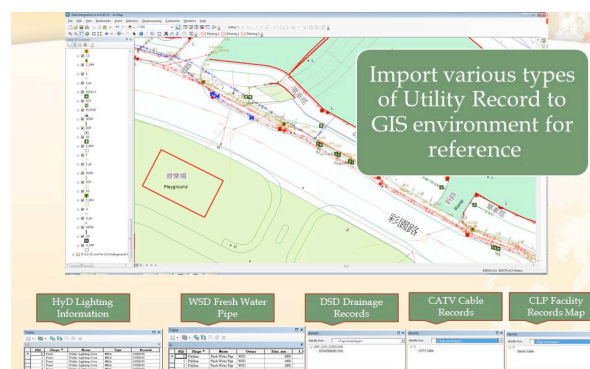


Figure 3 Checking of Utilities Record from Various Record

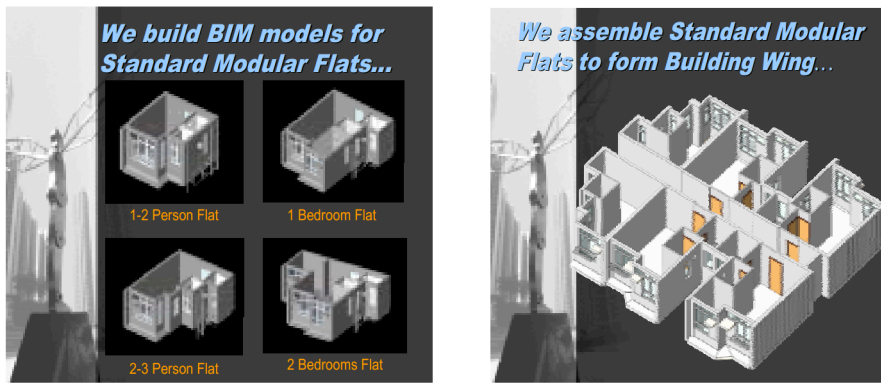


Figure 4. BIM – from Modular Flats to Feasibility Study

With the aid of BIM, project teams can build up modular flats, wings, floors and then form the whole block according to the parameters such as flat production and noise mitigation. With the completion of block design, the project teams can conduct feasibility studies on issues, such as, positioning of housing blocks, visualizing the flats orientation and views of the outside environment, etc. Project teams can also conduct environmental assessment to study the sun shadow effect on the blocks, wings and flats so as to select the most optimum design in utilizing the natural daylight. (Figure 4)

4.3 Detailed Design and Specification Stage

For the design of the building services, BIM can be applied to display the layout of building services installations, e.g. fire services water pipes, pump room, air conditioning installations, and water supply pipes housed in the ceiling void. This overall and integrated display facilitates the planning of preventive maintenance and emergency maintenance in the future. BIM is significantly useful in carrying out clash analysis of underground utilities services at the design stage thereby avoiding expensive remedial works at later stage as well as possible delay to the projects. (Figure 5)

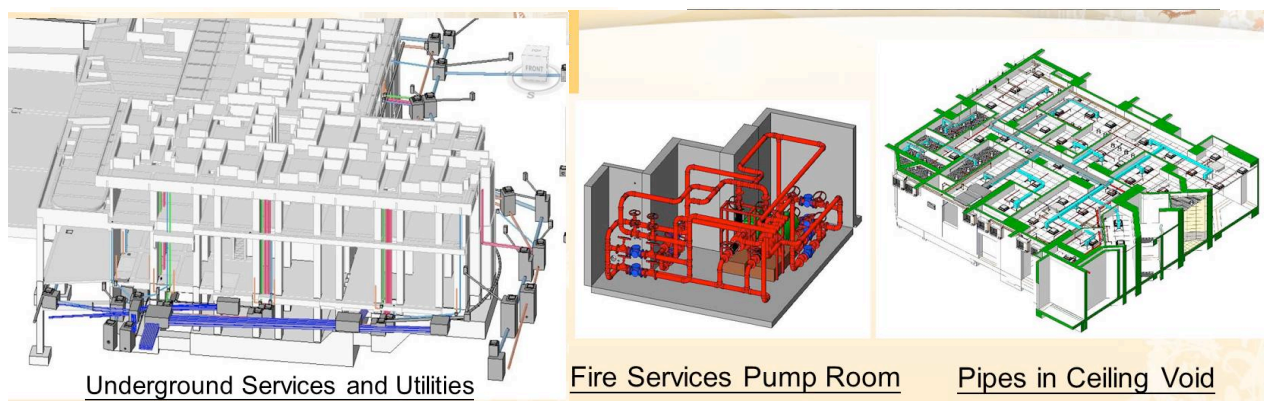


Figure 5. Design and Coordination of Building Services Installation

4.4 Construction Stage

During the Construction Stage, BIM enables project teams to simulate the complicated excavation works and demolition sequences so as to plan for a smooth and efficient work process and to ensure maximum safety of workers on site and others nearby. For example:

- The BIM model for the excavation and lateral support works were printed with a 3D printer; (Figure 6)
- Using the 3D Virtual and Physical Models, better visualization of the site conditions, planning and monitoring of the complicated Excavation and Lateral Support Works can be achieved;
- Accordingly, the contractor can fine-tune the sequence of work from high to low ground, from top to bottom of excavation, and from far to near side, as well as checking the adequacy of haulage space and ascertaining the haulage routes for the various stages. (Figure 7)

BIM has been applied to the ordering and delivery of materials, and making logistic and safety arrangement on site. For example, the positioning of tower crane, its operating space and the safety provisions can be visualized in advance, hence, a comprehensive site safety plan and measures can be drawn up accordingly. Using BIM to simulate the demolition sequence and extent is an effective site safety tool, for example, to erect fencing on roof and scaffolding around the building, and temporary supports for slabs and walls, etc.



Figure 6. Excavation Lateral Support for Site Formation Works

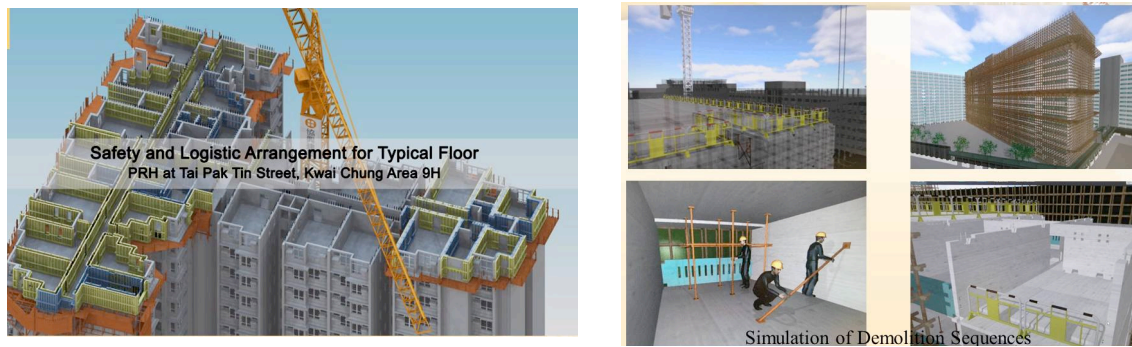


Figure 7. Safety and Logistic Application (Left) and Site Safety Planning (Right)

4.5 Maintenance Stage and Space Management

During the maintenance stage, BIM enables systematic storage, retrieval and presentation of building records for supporting facilities management. Records, such as, floor layout, design, disposition and height of shops, are inter-linked with Means of Access from staircases and escalators. It can also illustrate the shop front features, width of corridors, height and types of balustrades. Patronage simulation can be developed to visualize the future occupancies. 3D displays of building services installations facilitate the engineers to locate the exact defects in case of emergency or routine maintenance is required. A fly-through model can also be created for the tenants to visualize the possible shops layout design, shop front features, width and storey height, etc. before bidding for shop space, without having to conduct the site visit thereby saving time and cost.

BIM can display position and design details of an escalator in a particular floor for maintenance purpose. In assisting the maintenance of lifts or escalators, Certificate of Completion and Certificate of Periodic Maintenance can be retrieved from BIM database. This facilitates quick retrieval of document for planned preventive maintenance and emergency repair.

BIM is used to process glass wall information, and the specifications of lightings for maintenance purpose. ‘Domain’, a massive shopping centre developed by HD, is a successful example of using BIM. This model shows the mechanical, electrical and plumbing records of the Domain. The width, depth and storey height information of the premises are also stored in the system and facilitates subsequent partitioning or layout modifications of shops for space management. (Figure 8)

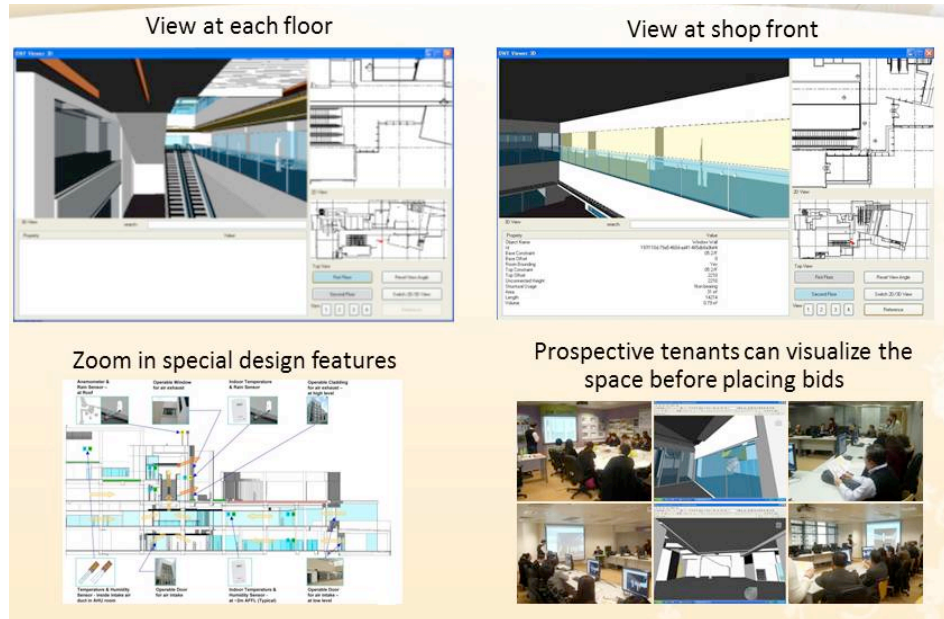


Figure 8. Facilities Management Applications

5. INTEGRATION OF GIS AND BIM

With the increasingly intensive use of GIS and BIM in supporting the development of public housing, there is a need to integrate these two datasets, which are created in different formats and platforms, so that the design data created in BIM can be automatically imported to the GIS environment for carrying out different types of analysis including visual assessment, ridge line analysis, calculation of total floor area for working out the plot ratio, retrieval of the design information, etc. This integration will streamline the workflow, enhance work efficiency, and ensure consistency of data.

Two different methods are explored on importing the building design models and its attribute data created in BIM to the GIS environment. (Figure 9)

In Method 1, the coordinates system of the BIM Models is transformed to the Hong Kong 1980 Grid System. The BIM models are then exported as IFC format and imported to BIMServer. Using BIMServer, the BIM models are further exported as CityGML. Then, BIM models in CityGML format are converted to ESRI File Geodatabase format by FME. (Przybyla (2010))

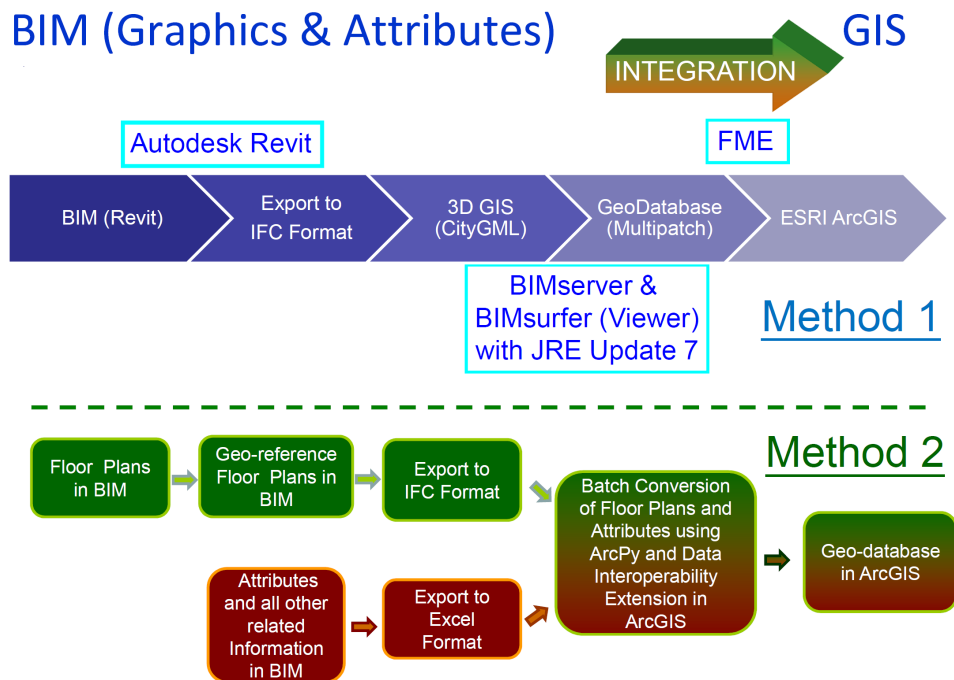


Figure 9. Data Conversion Methods from BIM to GIS

In Method 2, the coordinates system of the BIM model is transformed to Hong Kong 1980 Grid System. The BIM models are exported as FBX format. The attribute data of the BIM models are exported as Excel format. The spatial and attribute data are converted and combined into ArcGIS using Data Interoperability. Python script is used to automate the conversion process.

Method 1 involves more than one platform during the conversion, whereas Method 2 is confined to one single platform and the attributes data can be read in commonly used database format.

Method 2 has been applied to a massive housing development project at Shui Chuen O in the rural district. The area of the project site is 16 ha and the housing development consists of 18 blocks and 11,123 flat units. In the BIM software, elements of the modular flats are blended together into a unified floor model. The coordinates system of the model is converted from local to Hong Kong 1980 Grid System. Then, the spatial data and the attributes of the model are exported in IFC format and Excel format respectively. In ArcGIS, the spatial data and the attributes data of the model are converted and combined using Data Interoperability module. Python script is used to automate the conversion process. The floor model is stored in the File Geodatabase for the GIS applications. File Geodatabase is selected because the maximum storage of File Geodatabase can be up to 1TB, which is capable to handle the large storage requirement of BIM models.

In the GIS environment, scheme comparison, design enquiry, computation of Gross Floor Area and Plot Ratio and visualisation, are carried out. In ArcSence, the floor models are

added together to form a building block. Different floor design, such as number and floor area of flats, are made available in File Geo-database so that the design of the building blocks can be adjusted interactively in GIS environment for decision making on the optimum floor design. Attributes of the essential design, such as window size, are also converted to File Geo-database for enquiry and quantity survey application. The result of enquiry is not only in tabulated format, but also in visualisation of their spatial distribution in 3D perspective. The total floor area can be worked out or adjusted easily thereby facilitating the calculation of Gross Floor Area and Plot Ratio according to planning and building criteria. Panoramic view of the surrounding from any flat unit can be seen easily by inputting the location of observation point, the target building block, and the focal length of the camera. The scenery of each flat is customised by inputting the yaw, pitch and roll angles of the camera for generating an interactive perspective view.

6. CHANGE MANAGEMENT

In pursuing the use of GIS and BIM in the daily operations across the disciplines, from professional to technical personnel, the senior management of HD has personally involved in steering and supporting the change. Departmental committees of various levels, from steering committees to working groups to dedicated support teams have been formed. This has injected a powerful driving force to the technological evolution in HD.



Figure 10. 3D Matrix Team Structure of HD

(Notes: A-Architect, BSE-Building Services Engineer, CE-Civil Engineer, GE-Geotechnical Engineer, LA-Landscape Architect, LS-Land Surveyor, PO-Planning Officer, QS-Quantity Surveyor, SE-Structural Engineer)

A functional structure emphasizes more on effectiveness (quality) but less on interdisciplinary co-operation; a matrix structure emphasizes more on efficiency (managerialism) but the

project management teams lack expertise in managing quality. From 2002, HD has evolved to a 3D matrix team structure (Figure 10), merging the benefits of the two structures. While the increased use of sophisticated technologies and their inter-dependence between functions lead to greater need for co-ordination, the new organizational structure also enables more flexibility and adaptation to changing environment.

With the emerging and increasing use of GIS and BIM technologies and aiming at full implementation of BIM in design and construction from 2015, it poses a challenge for HD to build up a corresponding digital skill set across the organization. Apart from providing formal training courses, it is suggested to set up a central knowledge repository to collect knowledge through the departmental e-portal, through which peers can share their experience and achievements in work. Besides, peers can also gain the relevant experience by attachment to another project teams, which carry out GIS and BIM functions.

Rowlison (2001) highlights that if organizational change is to be effective and successful, change has to be culturally acceptable and promoted in a sensitive manner; commitment has to be built up in the group based upon relationships. All the staff of HD are deeply inspired by the core values of the Department, namely, the “4Cs” - Caring, Customer-focused, Creative and Committed - and they have built up a strong collaborative culture to fulfill the vision and mission of HD. With the full support of the staff and the determination of the top management to transform the organization and to modernize its technologies, it is anticipated that HD will be well equipped to meet the new challenges and to provide quality and in bulk public housing to those in need.

Changes are interactive. While HD changes its people, organization and technology, GIS and BIM also transform the business of HD. Processes that can be changed include up front design process, re-engineering, office procedures, professional and industry practices. Mode of partnership among project teams, consultants, contractors and sub-contractors can also be changed. While HD is getting prepared for the implementation of BIM, the construction industry in Hong Kong is not necessarily so. A reason is that currently there is no regulatory support to drive such change.

7. BENEFITS OF USING GIS AND BIM IN PUBLIC HOUSING PROJECTS

By applying the technological tool, accurate and up-to-date information of infrastructure can be made available for design, construction and maintenance work. With the use of GIS and BIM, the following benefits can be achieved in the public housing development:

- a. All the spatial data in GIS and BIM are preserved in 3-dimensional data format throughout the project life cycle. No data will be lost from one stage to another. These significantly enhance the consistency, quality and availability of spatial data to the project teams to carry out the interlinked design, construction and maintenance works in the project life cycle.
- b. GIS and BIM contribute to the sustainability of development of public housing

development because data of social, environmental and economic aspects are spatially related, which can be managed, accessed and analysed via GIS functionalities. Using the GIS technology, data is integrated in a unified geo-database, which supports project teams to access the most updated and comprehensive spatial information and enhances the quality of planning and design. The use of GIS and BIM technologies on the scheme design has enhanced the quality of decision. Integration of BIM and GIS bring 3D visualisation of the scheme design to stakeholders more effectively. (FUNG (2011))

- c. Environmental-friendliness is achieved in exploiting the technologies because accurate site information allows the use of standard components with quick assembly on site plus a more balanced or optimized cut and fill of the earthwork. This results in less in-situ works and less waste materials to be disposed of and the environment can be better protected.
- d. BIM enhances the planning for and provision of site safety measures through ready availability of prior understanding of site conditions and accurate location of machinery and utilities, and a virtual appreciation and walkthrough of the sites at different stages and times. Construction work can progress under a safe and assuring conditions to the benefits of all stakeholders concerned
- e. The integration of GIS and BIM achieves the objective of sustainability of development through a thorough analysis of the development from various perspectives and compliance with all essential or desirable requirements. GIS and BIM together provide a platform for project team to coordinate changes arising in the project life cycle. Timely updates can be made available for access by individual project team thereby enhancing communication and quick response to the changes. Duplicated works can be avoided hence minimizing material wastage, and simulation of environmental issues facilitate planning and design for better protection of the environment
- f. Last but not least, GIS and BIM together have shortened the design and construction time. Cost saving can be achieved by reducing construction waste and redundancy of work, the construction period can be shortened resulting in less financial charges, and the accommodation can be provided sooner to those in need.

8. THE WAY FORWARD

The current integration has focused on conversion of spatial and partial attributes data from BIM and GIS, and the integration with GIS data for enquiry and visualization applications. After the integration of BIM models and GIS data, it will open up a lot of analysis options for the planning, architectural design, engineering and maintenance aspects. This area is required to be explored with the project teams. With the success in applying BIM and GIS in housing development projects, the applications of both BIM and GIS will be widened to cover more new projects. More spatial analysis functions will be explored to enhance effectiveness at different stages of project life cycle. (Przybyla (2010))

With the success in the integration of BIM and GIS, it is planned to extend the data flow from BIM to GIS and vice versa. In addition, it will setup common attribute matrix between BIM and GIS database so as to minimise the impact on the further development and system upgrade of either BIM or GIS.

HD encourages our business partners to use BIM and GIS and to share the experience gained on the best practices used in housing development projects.

HD will collaborate with other government departments to design and build common platform to foster the data sharing. As more new development areas in Hong Kong are coming up, a new Common GIS Platform specifically for new development areas is considered necessary to be established to store the information, including planning, land status, housing production, infrastructure planning, design and project management, etc. to facilitate users to access and extract the required information for various purposes. Further studies are required to explore the scope of services through this platform, such as, consolidating the data from different sources and streamlining the retrieval for different applications.

9. CONCLUSIONS

With the mission to provide affordable quality housing to meet the needs of the public and to ensure effective use of public resources, HD is constantly exploring new and innovative ways for sustainable development and continuous improvement of public housing in various aspects. In facing the challenges from expediting the development process, the application of GIS and BIM is one of the most viable solutions.

GIS and BIM are now gradually employed throughout the life cycle of housing projects. GIS has its strength in spatial analysis and visualization during the feasibility study and conceptual layout stage and in asset management during the maintenance stage and in the long run. BIM plays a key role in the design process from the beginning of project. It provides a much tighter collaboration among design teams at an early stage to resolve any design problems, clashes and difficulties. It also enhances site planning, safety and project delivery. Data from these two platforms can be integrated to give synergy to this transformation in technology.

With the concerted effort of all stakeholders in the integration and use of GIS and BIM, HD has accumulated considerable experience in the evolution and transformation of technology, organization, processes, people and partnership. The evolution will go on as the demand for quality housing continues and the technology keeps on making a quantum leap.

- End -

REFERENCES

- FUNG Ada; CHENG Irene, (2011)**, How BIM & GIS help Project Planning and Utility Management with Safety & Sustainability in Mind – Housing Authority’s Experience. *Proceedings of the 2nd International Conference on Utilities Management and Safety (ICMAS 2011)*.
- Przybyla John (2010)**, The Next Frontier of BIM: Interoperability With GIS. *Journal of Building Information Modeling Fall 2010*.
- Rowlinson, S.M., (2001)**, Matrix organizational structure, culture and commitment: a Hong Kong public sector case study of change. *Construction Management and Economics*, **19**, 669-673.
- Willis Anthony, Sr; Masao Matsuko, (2007)**, Added Benefits Designing a geodatabase becomes the catalyst for an enterprise system. *ArcUser* January-March 2007.
- Young John, (2010)**, Convergence Yields Smarter Facilities: Practical Applications for Building Planners and Operators. *Journal of Building Information Modeling Fall 2010*.

BIOGRAPHICAL NOTES

Ms. Winnie SHIU:

Senior Land Surveyor of Hong Kong Housing Authority, the Government of Hong Kong Special Administrative Region, Fellow of Hong Kong Institute of Surveyors and Royal Institution of Chartered Surveyors, Registered Professional Surveyor (Land Surveying) of Surveyors Registration Board, Authorised Land Surveyor of Land Survey Authority.

PUBLICATIONS

- *Geographic Information – Organisation Challenges in the Hong Kong Context*, 2nd FIG Regional Conference, Marrakech, Morocco, Dec 2003
- *Internet Maps for the Community in Hong Kong*, FIGWW2004, Athens, Greece, May 2004 and *GIS Development* July 2004 Vol 8 Issue 7
- *Surveying and Construction of Public Housing in Hong Kong*, 3rd Cross Strait Geomatics Conference in Hong Kong, 14 October 2010
- *Evaluation of Mobile Mapping System (MMS) Survey for Public Housing Estates in Hong Kong*, FIGWW2012, Rome, Italy, May 2012
- *Building Monitoring Survey of Public Housing Estates in Hong Kong*, First International FIG Workshop on Monitoring High Rise and Tall Engineering Structures, Hong Kong 22-23 November 2012
- *Evaluation of the Applications of Unmanned Aerial System Survey in the Development of Public Housing Estates in Hong Kong*, 7th Cross Strait Geomatics Conference in Hong Kong, Nov 2013

CONTACT

Winnie SHIU
Hong Kong Housing Authority
9/F, Block 3, 33 Fat Kwong Street, Homantin
Kowloon
Hong Kong

Tel. +852 21293188
Fax +852 26250924
Email: shiuwinnie@yahoo.com
Web site: www.housingauthority.gov.hk