Filling the space

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Enriching building information models with cadastral information could meet land administration challenges in complex cities, explain Behnam Atazadeh, Mohsen Kalantari, Abbas Rajabifard and Tom Champion

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Over recent decades, urbanisation has led to unprecedented pressure on development and use of land in world cities, which have seen a growing number of multi-storey buildings and other urban infrastructure. Urban built environments are becoming more complex.

Such complexity requires collaborative and multidisciplinary approaches to manage cities in an optimal way. One requirement is effective management of spatial information about rights, restrictions and responsibilities that are associated with the ownership of land, buildings and airspaces.

Land administration systems are responsible for storing and disseminating information about such ownership arrangements. These systems use 2D subdivision plans to delineate cadastral boundaries, which efficiently represent the spatial extent of cadastral spaces in buildings with simple structures.

However, they face challenges when mapping the spatial extent of ownership interests in multi-storey buildings with complex architectural configurations. The viability of 3D digital technologies to meet these challenges is being investigated. One of these 3D technologies is building information modelling (BIM), which can help manage buildings over the course of their life cycle.

There is detailed information about structural and architectural building elements in BIM models. However, there is no information about ownership of private and common property spaces. By enriching BIM models with cadastral information, though, there is the potential to address the current challenges in urban land administration.

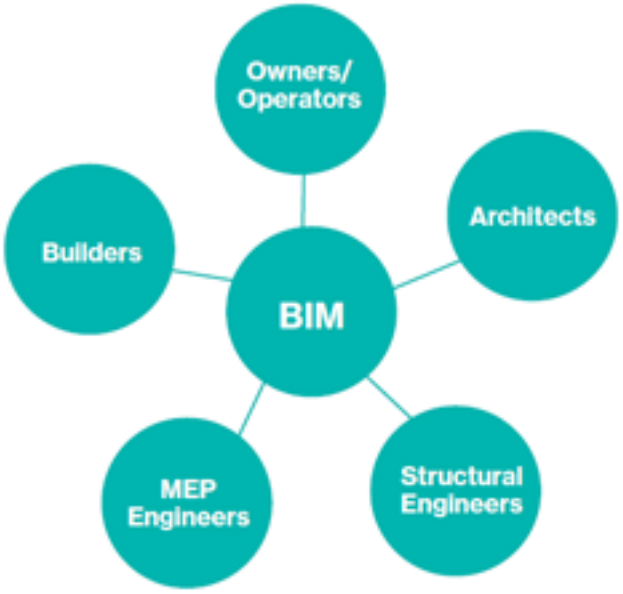
The following list sets out a range of such administrative challenges.

- Flat and 2D-based representations may not show 3D delimitation of cadastral spaces inside buildings with irregular and complex shapes effectively.
- Multiple pages of 2D drawings, which are used to show all cadastral spaces in high-rise buildings, make it difficult for owners to understand the 3D limits of their interests.
- Delineating the boundaries for common areas, made up of stairs, elevators, lobbies and corridors passing through several storeys, is very difficult using 2D plans.
- Defining cadastral boundaries from a building?s physical elements such as walls, windows or doors is also a challenge. For example, in the Australian state of Victoria, these boundaries are defined using one of three relationships with the physical element: touching the interior face, touching the exterior face, or passing the median of the physical element itself. A person with inadequate knowledge could

quite easily misinterpret the boundary.

Building information modelling

BIM is mainly recognised from 2 distinct perspectives, namely process and product. From a process perspective, BIM is a way of creating, storing and sharing building information, enabling multidisciplinary collaboration and communication among various stakeholders involved in the development, management and operation of buildings (see Figure 1).



The BIM process is based on 3D physical as well as functional information about a building to support various decisions that need to be made during its life cycle.

The prominent features of a BIM product are object-oriented data structure, rich semantic and spatial information supporting 3D spatial relationships between building elements, and extendable data models. BIM provides productivity benefits and cost savings in various phases of a building?s life cycle, from conception to demolition.

Figure 1: BIM enables collaboration between the architecture, engineering and construction sectors

In the architecture, engineering and construction industry, BIM has helped to overcome challenges posed by using 2D drawings or even 3D CAD models. There are, however, some obstacles to the adoption of BIM in the industry. The most prominent technical challenge is interoperability; that is, the ability to exchange data between different BIM platforms correctly. This issue stems from the fact that each BIM platform has its own data format for using a model.

The BuildingSMART organisation has developed the Industry Foundation Classes (IFC) standard as an open data model to enable interoperability and data exchange among BIM platforms.

A cadastral BIM model

To showcase the viability of BIM for managing 3D cadastral spaces, a prototype model for a multi-storey building in Melbourne, Australia, has been developed in Autodesk Revit software. Revit does not provide 3D visualisation of spaces, so the model was converted to IFC standard format and the open-source BIMServer and BIMViews were used to visualise the model in a web browser with WebGL capability.

Both private and common property cadastral spaces were defined in the model, and ownerships associated with cadastral spaces incorporated. For each private cadastral space, information about its owner, land use and title can be accessed (see Figure 2). Similarly,

information about each communal cadastral space, such as its responsible owner?s corporation, is also provided.

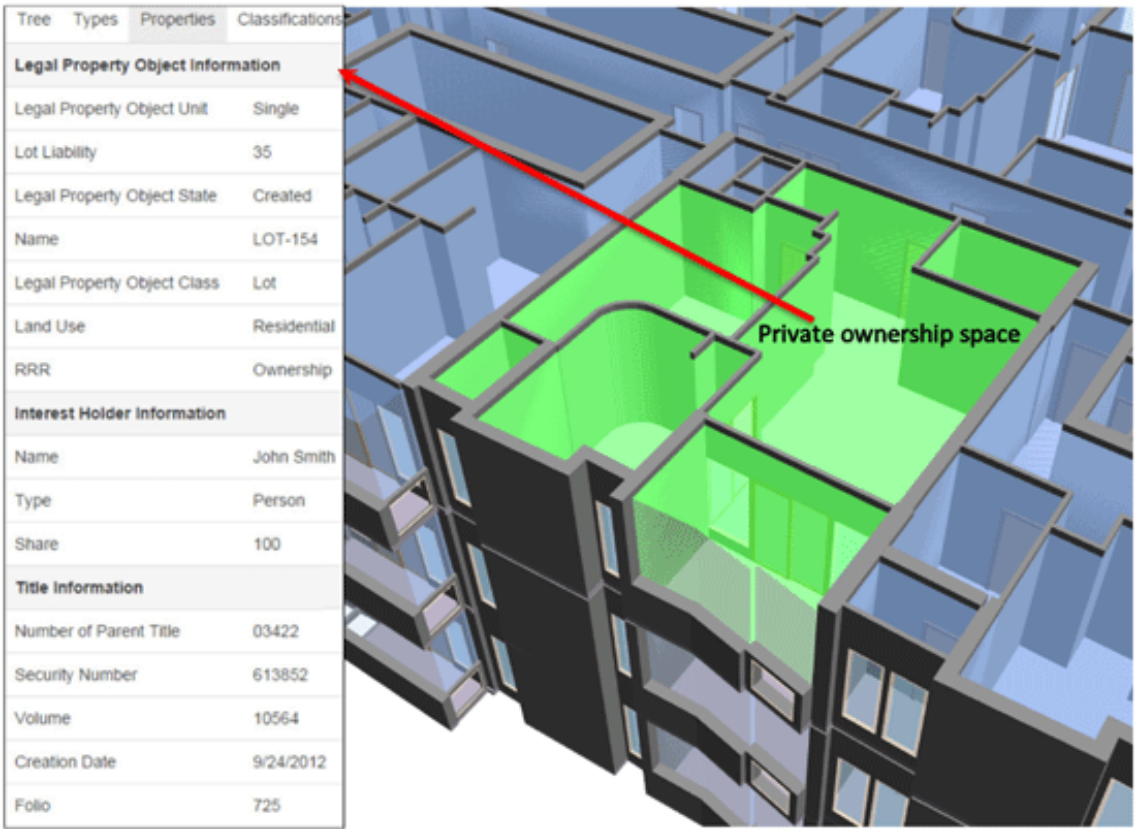


Figure 2: An example of a private cadastral space in the prototype

Different types of physical boundaries were delineated to demonstrate the potential of the BIM data environment to help the communication of those boundaries. For example, it enables users to distinguish whether a physical boundary touches either the interior face or exterior face of a wall, or whether it intersects the median of the wall (see Figure 3).

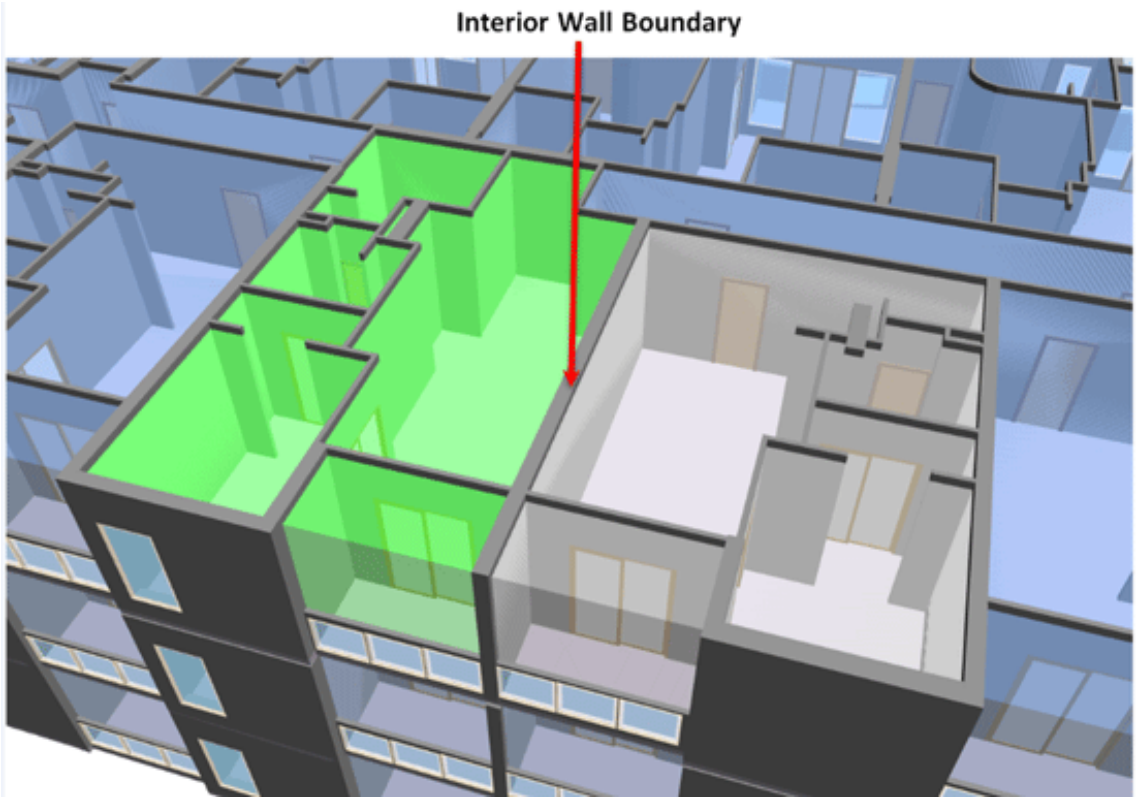


Figure 3: A median wall boundary

Benefits of BIM

The prototype model shows that BIM can offer some benefits for managing stratified cadastral spaces in an urban built environment. The first benefit would be enhancing visual communication of interweaved, stacked and complex cadastral spaces for non-specialists.

The rich spatial and semantic information about physical structures in 3D models can help understanding of cadastral boundaries, providing an unambiguous delineation of ownership, rights, responsibilities and restrictions.

Additionally, using BIM environments for managing cadastral information can advance current land administration systems from a 2D-based and analogue data environment into a 3D digital, interactive and dynamic one.

BIM can also unlock value in cadastral information by forming a bridge with the interactive life cycle and management of the building. Another benefit would be determining various responsibilities related to the maintenance and management of assets and facilities in buildings.

Incorporating cadastral boundaries into BIM can reveal who is responsible for repairing damage. For instance, if a wall boundary between two apartments is interior, the wall is part of

a common property area. This shows that enriching BIM with cadastral information would enable enhanced collaboration between land administration and facility management systems.

Conclusion

BIM can provide a feasible solution to help communication of complex cadastral spaces. The prototype model demonstrated how different types of cadastral space as well as physical boundaries can be managed in the 3D BIM digital data environment.

The highlighted benefits indicate the impact a BIM-based land administration could have in the governance of an urban built environment.

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Further information

- Images courtesy of the authors
- Related competencies include Cadastre and land management , Building information modelling (BIM) management
- This feature is taken from the RICS *Land journal* (March/April 2016)