Reconstructing land tenure maps of Australia in 3D

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SUMMARY

Exiting land tenure data above and below ground, such as apartment ownership, tunnels, and utilities, are maintained using 2D drawings. State and territory governments and companies operating utilities and infrastructures in Australia are investing in reconstructing 2D plans and surveys into 3D digital models, as data on 2D drawings are not structured and helpful for detailed and advanced visualisation, analytics, modelling, and simulation.

Researchers have investigated methods for creating 3D cadastral models of buildings and infrastructures at the design stage. The literature has studied and developed approaches to sourcing reference data (e.g., BIM) to create 3D cadastral models. It has extended built environment data models (e.g., CityGML, IFC) to accommodate 3D cadastral data. It has also developed visualisation (e.g., 3D PDF) and storage (e.g., geodatabases) approaches. The studies have found a knowledge gap in reconstructing 2D land tenure records of existing buildings and infrastructure into 3D. The literature suggests that the theory for reconstructing 3D tenure data relies mainly on the geometrically defined tenure dimensions. The knowledge gap is attributed to the existing drawings' ambiguous and sometimes omitted data. The tenure data is often implied in the drawings and not always spatially shown or explicitly recorded. For example, 3D data such as depth limitation or the distance between a ceiling and floor may be provided in a notation or sometimes not recorded in the drawing. Ownership boundaries of apartments are often defined by physical elements such as walls, slabs and floors. Cadastral plans with cross-sections assume that any other parallel cross-section will result in the same profile and ignore any potential change in height.

The ambiguous and omitted data on current 2D land tenure drawings increasingly create commercial and social challenges. For example, we observe several infrastructure and utility projects that run over time and cost due to omitted data. Due to ambiguous data, we also see

increasing ownership disputes in apartment living in Australia.

Using the current back-capture approaches, we would rely on geometrical explicit data only, omit implied tenure, and consequently create invalid 3D central models. This would lead to problems during or after property registration, as errors and ambiguities in digital representations of tenure result in disputes and litigation.

This paper investigates the level of detail required to create valid 3D cadastral models and develops automated methods to ensure the validity of the reconstructed models. It provides validation principles for 3D cadastres and formalises them in mathematical and geometrical terms. It implements these terms into algorithms that can be used in 3D modelling software tools. Building on this, the paper recommends potential changes in surveying practices to facilitate the achievement of 3D cadastres in Australia.