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## Title:
## BIM-based 3D Registration of Condominium Rights Through Integration of the Standards

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**Name of Academic Institution:** Istanbul Technical University

**Level of study or work:** PhD Thesis
(Bachelor thesis, master, research, project, etc.)

**Information about you (and your team):** I am a Dr. Research & Teaching assistant at the Department of Geomatics Engineering of Istanbul Technical University (ITU), Türkiye. I obtained BSc, MSc, and PhD degrees in 2015, 2016, and 2022 respectively in the same department. I published several papers on 3D land administration and GIS-aided urban planning in international journals such as *Land Use Policy*, *Building and Environment*, and *Sustainable Energy Technologies and Assessments* and recognized conferences such as *3D GeoInfo* and *FIG Congress*. I serve as a reviewer for a number of journals such as Sustainable Cities and Society. I have a significant experience with the roles of researcher and principal investigator within the research projects that were supported by the university funding agency and The Scientific and Technological Research Council of Türkiye (TUBITAK). I was a visiting researcher for a year at the University of Colorado Boulder, USA starting from August 2019 through International Research Scholarships for Research Assistants (YUDAB) by the Türkiye Council of Higher Education (YOK). I was also awarded the International Federation of Surveyors (FIG) Foundation PhD Scholarship in 2021 and carried out a research visit to Delft University of Technology (TU Delft), The Netherlands in 2022. I am a management committee member of the European Network for Digital Building Permits (EUnet4DBP). I have experience as a teaching assistant and lecturer for several courses such as Land Management and Spatial Analyses and Algorithms in GIS. Recently, I was awarded ITU Best Doctoral Thesis Award for Geomatics Engineering in 2023. I am also an organizing and scientific committee member of Digital Building Permit Conference 2024.

## Area of interest
(Identifying the problem, explain why it is important and the current relevance of the topic, up to 250 words)

These days, the sustainable development of smart cities has become crucial due to climate change and excessive urbanization that substantially force governments to practice complex strategies. These strategies that contain the improvement of the infrastructure facilities, city services, and environmental quality aim to secure wealth, habitability, and healthiness for citizens. In this connection, effective land management is vital for the sustainability of the built environment. In relation to this, solid Land Administration Systems (LAS) are needed in order to put into practice effective land management. These systems deal with recording the information on Rights, Responsibilities, and Restrictions (RRR) in a cadastral database as components of property rights that may occur both underground and aboveground. With rapid migration and, as a result, rapid population growth, a large number of buildings are being built on the lands in urban areas. This transformation has led to the construction of multi-storey buildings, considering that the expansion of urban areas continues

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in certain regions. Because of the developing technologies, the complexities of these multi-storey buildings are increasing day by day. At this point, it is the dominant view in the international literature that LAS need to be developed such that they have the capacity to process and manage three-dimensional (3D) data in the registration of property rights. In other words, it is a fact that 2D data is insufficient for the complete registration of the property rights subject to condominiums in today's multi-storey and complex buildings.

## Approach to the problem

(Describe your methodology or technology and how it will solve the problem you identified, up to 300 words)

Thanks to Building Information Modelling (BIM), building models can be obtained in 3D in detail by using an object-based modelling approach. Further, the interoperability of the obtained BIM models between different stakeholders and applications is ensured by the open data standard named Industry Foundation Classes (IFC) standard. Land Administration Domain Model (LADM) provides a conceptual model that includes activities related to land administration, stakeholders, spatial objects, and relations between them in order to create a common basis. In light of the information, the main purpose of the doctoral research was to provide the integration between LADM and IFC standards in order to be modelled the condominium rights in 3D including both physical building elements and logical spaces, together with the semantics regarding their cadastral registration. For this purpose, 3D condominium applications around the world were examined and an analysis of the current situation was carried out. By using the result of the analysis, an integrated model was developed in which appropriate relationships are established between the features in the LADM standard and the entities in the IFC schema (Figure 1). To test the applicability of the developed model, a BIM model of a sample building was created and the final IFC model was obtained by enriching the content of the created building model (Figure 2). It is made possible to model RRR in the context of cadastral registration for various building elements as well as legal spaces subject to condominium rights. It is demonstrated that it is possible to unambiguously represent the property rights subjecting to condominium and to register those in the land registry through the reuse of the especially as-built BIM models approved in the occupancy permit process as a part of the building permit issuing.
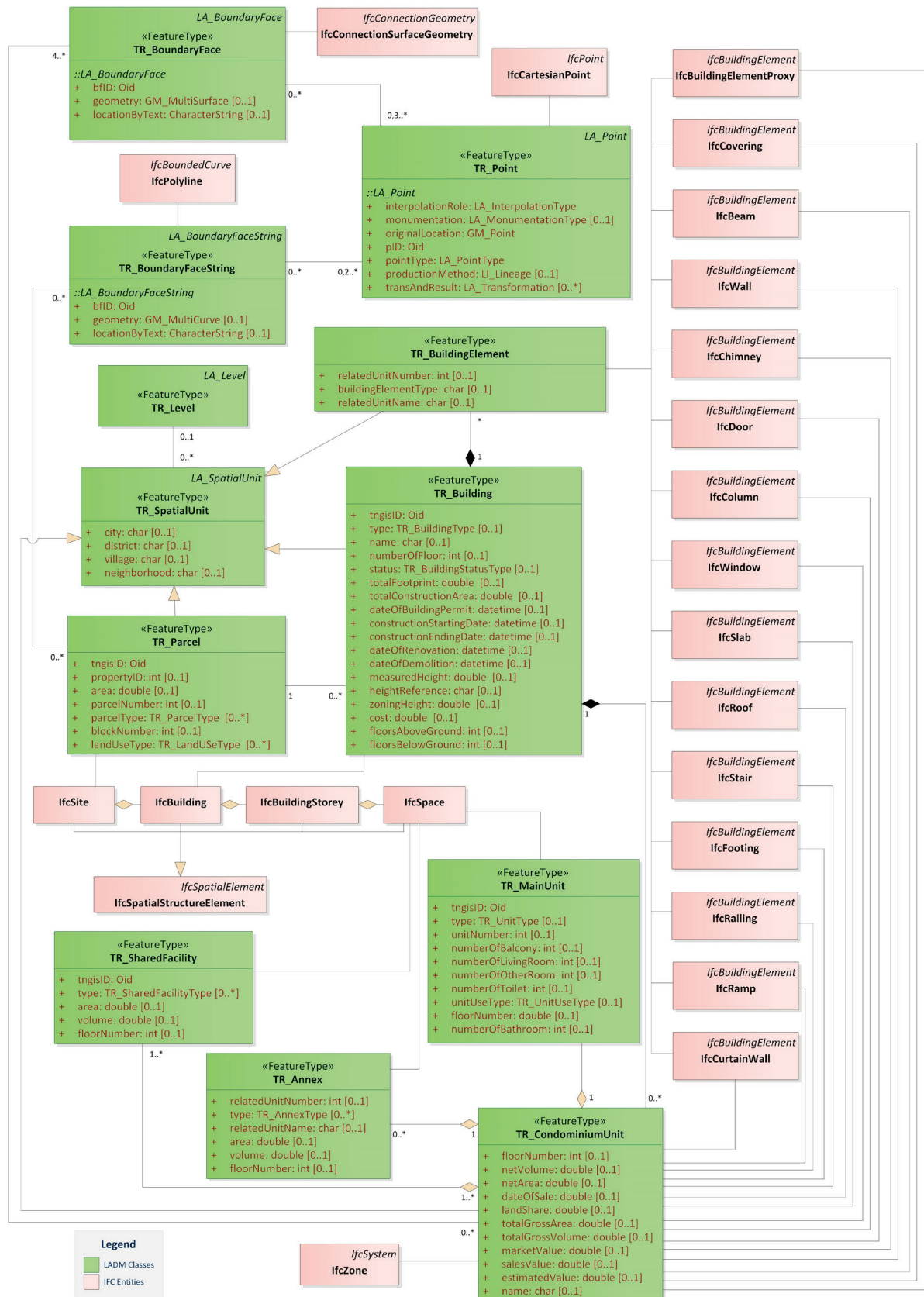
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Figure 1. Part of the integrated model.

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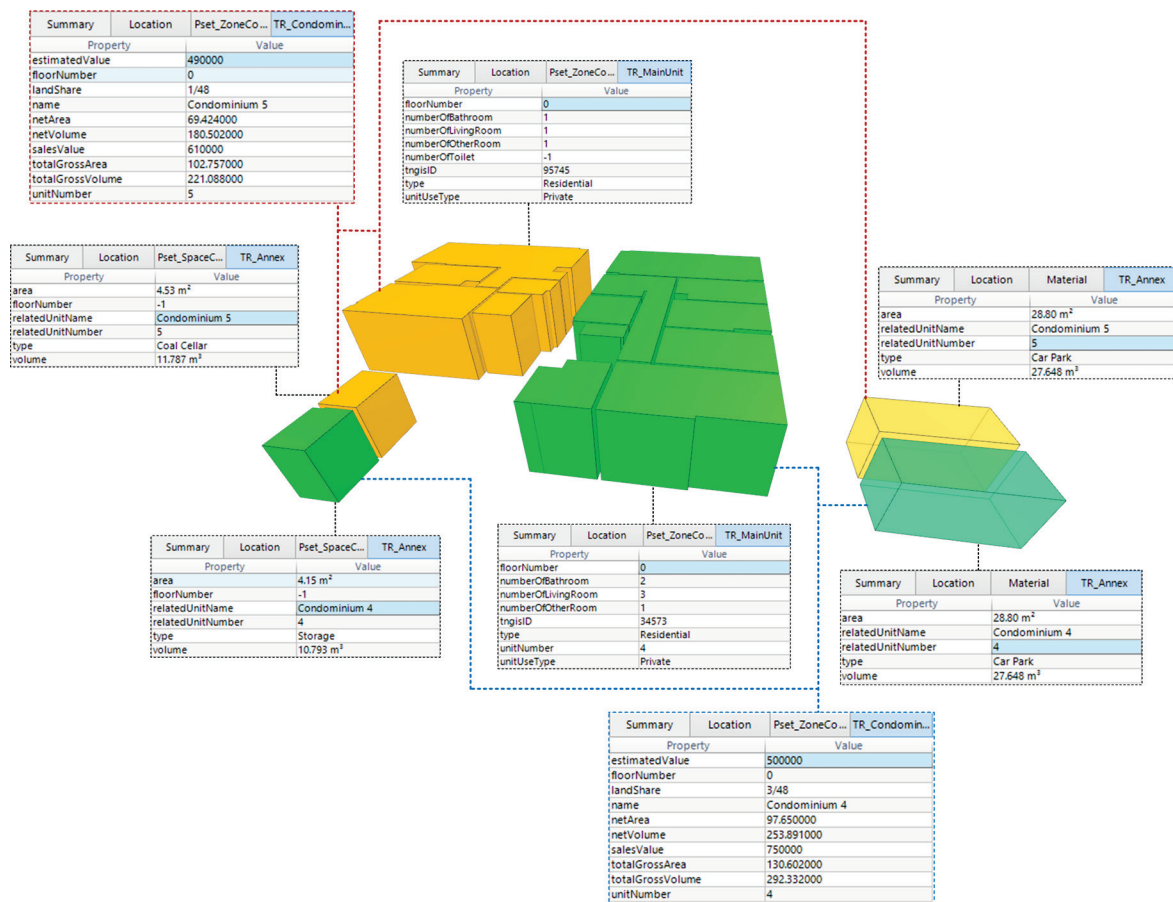
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Figure 2. The condominium examples.

## Results, conclusions and next steps
(Present your research results and conclusions of your study, up to 250 words)

The concluding remarks can be conveyed as follows:

- BIM models offer an important option for 3D modelling of the legal spaces regarding the condominium rights that can be composed in the buildings,
- Although the IFC schema does not contain special entities and properties regarding the condominium rights, 3D digital models that can be used in registering the condominium rights can be obtained through expanding the existing entities with new property sets and properties,
- Enriched IFC models are significant resources that can be used in 3D LAS transformation because they provide 3D spatial information and semantics with respect to condominiums and related property counterparts such as annexes,
- Valuations of condominiums for taxation purposes can be determined more realistically and scientifically by using comprehensive BIM/IFC models, and thus the problems associated with declaring the value of a real estate can be minimized,
- By using the obtained BIM/IFC models in energy analysis of buildings, more accurate evaluations can be made regarding the dissemination

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of green energy and renewable energy in the context of sustainable development,

- BIM/IFC models used in the registration of condominium rights can be converted to different spatial data standards such as IndoorGML,
- Considering that digital building permitting is based on the use of BIM in general and IFC models in particular, it is necessary to ensure that BIM technology is effectively adapted to the industries involved in the process, such as the AEC, land administration, and spatial planning (Figure 3).
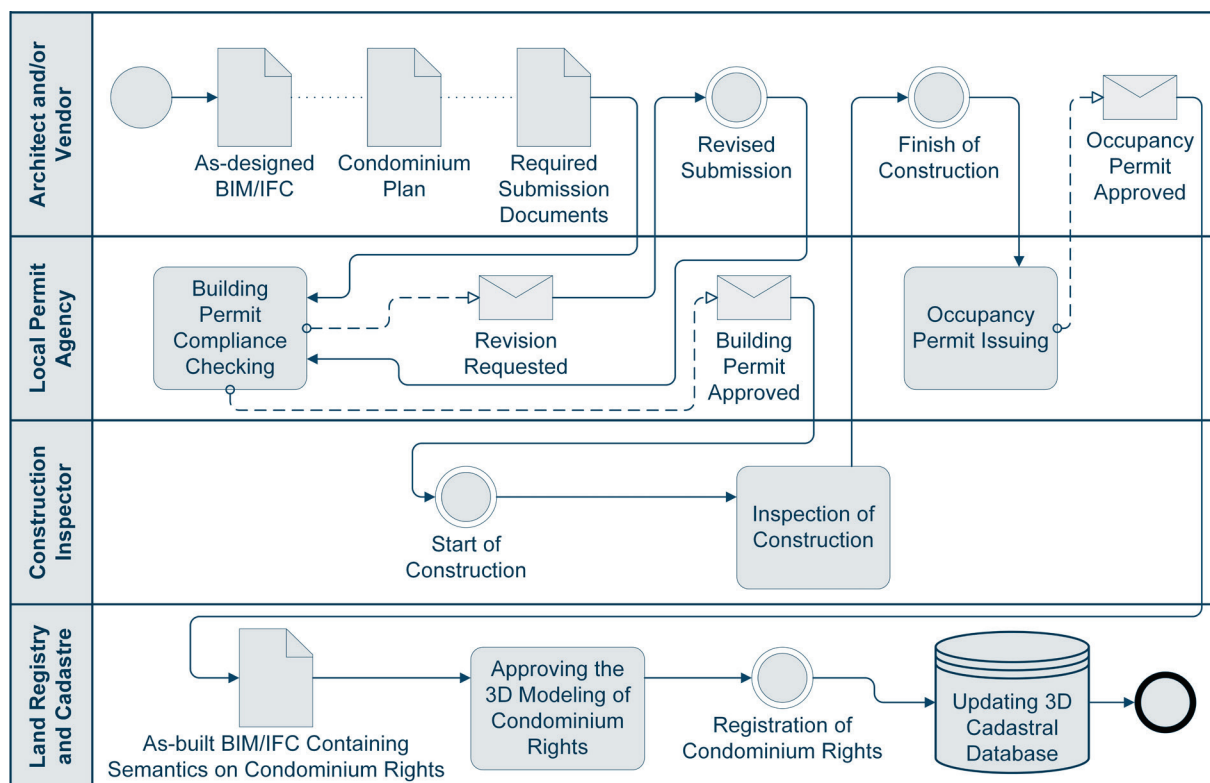


Figure 3. A BIM/IFC-based workflow for 3D cadastral registration.

### References
(Additional information, publications, or links, up to 200 words)

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