BIM for Geoinformation in Malaysia and Turkiye - Current Status

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Abstract

This paper reviews the status and progress of Building Information Modelling (BIM) with geoinformation systems in Malaysia and Turkiye, emphasizing their respective efforts toward 3D digital land administration. Both countries recognize BIM as a key enabler in the digital transformation of the built environment, supporting spatial data management, cadastral modernization, and smart urban governance. In Malaysia, particularly in Sarawak, the integration of BIM with the Land Administration Domain Model (LADM) focuses on native customary rights (NCR) land and enhancing strata management through semantic enrichment of 3D building data. This research-driven initiative by Universiti Teknologi Malaysia (UTM) and the Land and Survey Department Sarawak highlights the potential of BIM – LADM mapping for transparent and efficient 3D registration of legal spaces. Conversely, Turkiye has made notable progress through government-led pilot projects such as Amasya and Yenimahalle, which demonstrate operational integration of BIM, LADM, and CityGML for 3D cadastre, condominium ownership, and urban infrastructure management. In comparison, Malaysia takes approaches driven by local legal needs, while Turkiye focused on national policies and data standards. Despite these differing approaches, both nations face shared challenges in semantic conversion, georeferencing, data harmonization, and limited institutional capacity. The findings conclude that BIM and geoinformation offers significant potential for improving digital land administration in both countries. To advance this goal, the paper recommends strengthening policy frameworks, enhancing capacity building, and promoting collaborative research to develop standardized workflows for BIM – LADM integration. Joint Malaysia – Turkiye initiatives under international platforms such as ISPRS or FIG could accelerate the realization of interoperable 3D cadastral systems and contribute to global advancements in smart land governance.

1. Introduction

1.1 BIM

Building Information Modelling (BIM) is being utilized in several domains such as in architecture, engineering, and construction (AEC) including geoinformation in many parts of the world (e.g., Malaysia and Turkiye) (Abdul-Rahman et al., 2018). It becomes an essential component in digital transformation of the built environment which supporting facility management processes. BIM is increasingly recognized for its potential in geoinformation and land administration, enabling the integration of geometric and semantic data to support 3D city modelling, digital cadastre, and smart urban management (Abdul-Rahman et al., 2018; Alattas et al., 2021; Broekhuizen, 2021). Integrating BIM with geospatial data enhances the ability to visualize and manage legal, physical, and administrative spaces in three dimensions, allowing for more accurate representation of complex urban environments (Atazadeh et al., 2021; Liu et al., 2023). This is particularly relevant for countries moving toward digital land administration and 3D cadastral systems, where interoperability between BIM and geoinformation is critical to achieving transparent, efficient, and data-driven land management. Figure 1 illustrates the conceptual layering of GIS data and how BIM adds an additional level of detail, enhancing the representation of real-world environments.

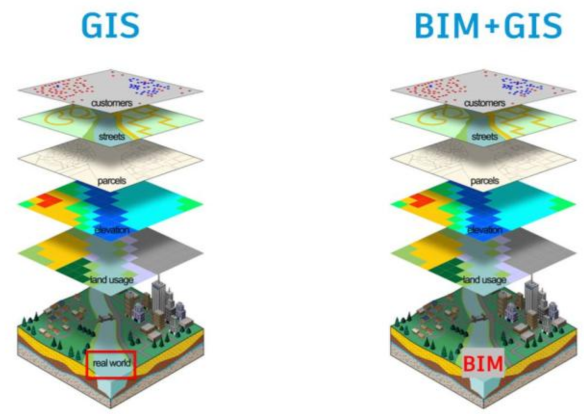

Figure 1. GIS and BIM level of representation (retrieved from Porkolab P., 2025)

In general, BIM-geoinformation aspects in Malaysia still at early stage of research and development (R&D) where most of the works related to conversion and there is no clear significant output. The scenario provides opportunity for more research and projects collaboration between academia and industries in Malaysia. The same scenario in Turkiye. Both countries are now working toward a more BIM-compliance surveying and geoinformation projects. Turkiye already embarked on large-scale BIM project specifically for Istanbul International airport in 2018 and completed. Recently, big buildings construction in Malaysia also BIM-compliance, however, not all construction projects based on BIM. Furthermore, BIM-geoinformation or BIM-surveying is yet materialized in both countries.

Currently, the integration of BIM and geoinformation triggers more studies and research to leverage the potential of generating useful information including for 3D group users (Alattas et al., 2021; Broekhuizen, 2021). Both countries (Malaysia and

Turkiye) are currently investigating policies, legal frameworks, and technical infrastructure to support BIM-enabled geospatial systems to align with global trends toward open standards and integrated workflows as seen in countries like Singapore, the Netherlands, and Sweden (Guler et al., 2022; Gürsoy Sürmeneli et al., 2022). The domains have been discussed in various platforms by the relevant societies and communities in these countries. This paper reviews existing national initiatives, legal frameworks, and pilot projects in both Malaysia and Turkiye as follows. Section 2 describes use-cases, Section 3 discusses on issues, conclusion in Section 4 and future recommendation in Section 5.

2. Use-cases

Many countries (e.g., Sweden, Singapore, Netherlands, Australia) have utilized BIM for various purposes, normally within local authorities with specific applications for example, 3D parcels or objects registration, strata mapping, 3D city models, land administration and ownerships, including other related applications (building permits and licenses). BIM also being investigated for legal space conflicts between building ownership boundaries and rights, restrictions, and responsibilities (RRRs) as reported by Liu et al., (2023).

2.1 BIM-GIS status in Sarawak, Malaysia

Currently, Sarawak is actively engaging BIM and GIS for land administration where the Land Administration Domain Model (LADM) is being applied together with BIM for semantic information. This initiative is to develop a 3D Land Administration (LA) as a way to improve the management of the land parcels and strata. At the moment, the authority is at the stage of investigating the approach together with the Universiti Teknologi Malaysia (UTM), 3D GIS research group. The work is at the early stage – it is to address challenges in strata property management. This recent research focuses on leveraging BIM to enhance spatial and legal data management through LADM integration. It proposes a structured methodology for extracting BIM/IFC data and mapping it into Sarawak's LADM country profile to improve transparency and automate strata registration, including detail legal space visualisation as illustrated in Figure 2.

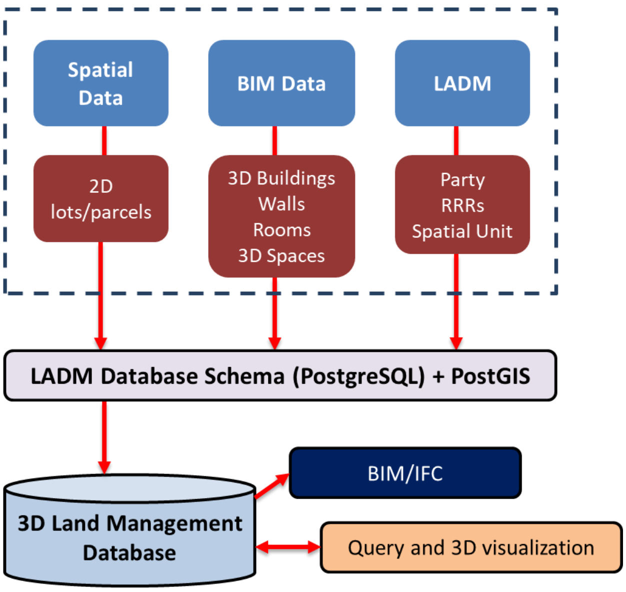

Figure 2. BIM-LADM Framework for Sarawak

A key enabler for this integration is the adoption of IFC4 and higher Levels of Detail (LoD), which support better alignment between BIM data and LADM workflows. This aligns with Sarawak's broader digital transformation goals, especially in the management of 3D strata properties. BIM implementation in Sarawak differs from Peninsular Malaysia due to distinct legal frameworks as reported by Zamzuri et. al., (2025).

- Sarawak uses the Sarawak Land Code 1958, while Peninsular Malaysia uses the National Land Code 1965.
- Native land rights in Sarawak are governed under Native Customary Rights (NCR), which provide stronger protection and different ownership restrictions compared to the Aboriginal Peoples Act 1954 in Peninsular Malaysia.
- For strata properties, Sarawak enforces the Strata Management Ordinance 2019 (Chapter 76), whereas Peninsular Malaysia applies the Strata Titles Act 1985.

These legal differences, BIM–LADM integration in Sarawak requires localised adaptations for NCR lands and strata ownership regulations. In terms of legal space definition:

- Ownership boundaries are typically based on inner walls, floors, and ceilings.
- External walls, beams, and columns are common property, even if they enclose a unit.
- Shared elements like windows, doors, and balconies can be either private or common property depending on the strata plan.

This legal structure strongly influences how IFC elements (e.g., IfcSpace, IfcRelSpaceBoundary, IfcBuildingElement) are mapped to LADM classes to represent legal and physical boundaries in 3D strata management in Sarawak.

2.2 BIM-GIS status in Turkiye

Turkiye has made notable progress in the adoption of BIM and its integration with LADM, particularly through national pilot projects that emphasize 3D cadastre. The country is in the early stages of operational BIM–GIS integration, primarily driven by metropolitan municipalities and national land administration agencies. These efforts aim to modernize cadastral systems, improve spatial data management, and enable digital representation of volumetric property rights.

A central component of Turkiye's strategy involves adopting open and standardized data formats such as IFC, CityGML, and LADM (ISO 19152) to support cross-domain interoperability. Several key initiatives reflect this direction:

- Amasya Pilot Project (General Directorate of Land Registry and Cadastre (TKGM)) – Demonstrated the integration of 3D city models with cadastral maps and BIM interior data, employing an LADM-compliant structure to represent both spatial and legal components of property units.
- Yenimahalle (Ankara) Project – Focused on 3D condominium mapping using IFC-BIM models, integrated with title deed information to model volumetric property rights under the LADM framework (Guler, et. al., 2022).

- TAKBİS Modernization Initiative – Aimed at migrating existing cadastral systems to an LADM-based data model, while integrating with GIS and spatial web services (WMS/WFS) to enable more advanced and interoperable land information systems.

These pilot projects collectively explore the use of BIM as a foundational data source for digital cadastre, highlighting its potential for representing both geometric and semantic components of built environments. They also emphasize the value of LADM in structuring legal property information alongside physical building data. Turkiye's integration approach involves harmonizing multiple data formats as reported by Gursoy et. al., (2022):

- IFC for building geometries and semantics,
- CityGML for parcel geometry and spatial relations, and
- XML for legal ownership, restrictions, and responsibilities.

This integration is supported by a centralized spatial database architecture, typically based on PostgreSQL and PostGIS, with API service layers providing land and zoning data through web services.

The implementation of BIM and LADM in Türkiye supports a diverse range of practical use cases that strengthen the country's digital land administration framework. One key application is 3D condominium ownership, where volumetric property rights are integrated with BIM and cadastral datasets to enable accurate representation of multi-level property units. In addition, the framework is applied in urban transformation projects, particularly those involving informal land rights and complex zoning regulations, to improve the clarity and reliability of property information. BIM–LADM integration is also leveraged for underground infrastructure mapping, allowing the registration of subsurface assets such as metro lines and pipelines as 3D spatial units. Another significant use case involves cultural heritage documentation, where HBIM (Heritage BIM) models are aligned with LADM to capture both geometric and legal information for protected heritage sites. Table 1 represents the LADM use cases in Turkiye together with their focuses.

Table 1. LADM Use Cases Specific to Turkiye

Use Case	Focus
3D Condominium Ownership	Volumetric rights via IFC – BIM + cadastral linkage
Urban Transformation Areas	Informal rights, zoning – title modelling
Underground Infrastructure	Metro & pipelines via 3D spatial units
Cultural Heritage Documentation	HBIM + LADM for legal/geometric modeling of heritage
Unregistered Land Use	Social tenure for yayla/mera zones
e-Government Visualization	Public access to 3D ownership via LADM-based platforms

In the meantime, Turkiye is advancing public visualization of 3D property ownership information through national e-government platforms, providing improved accessibility, transparency, and support for informed decision-making in land administration. Another project of 3D visualization within BIM – GIS can be considered as a use case in Turkiye. The following figure (Figure 3) illustrates 3D visibility analysis with respect to BIM and GIS.

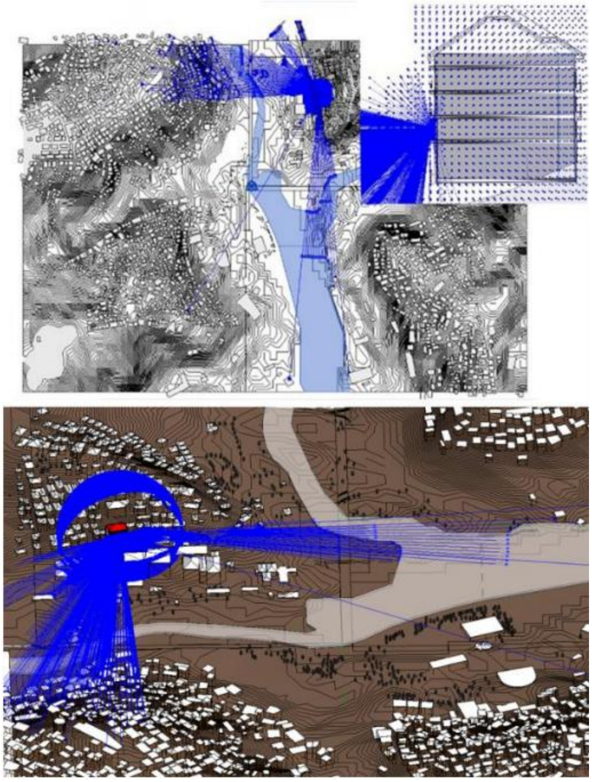

Figure 3. 3D visibility analysis with respect BIM and GIS (adopted from E. Corlu & Isikdag, 2024)

2.3 Comparative Analysis: Malaysia and Turkiye

The integration of BIM and geoinformation in Malaysia and Turkiye demonstrates different levels of institutional maturity but converges on common technical and semantic goals. Table 2 summarizes the comparative overview of both countries based on legal, technical, and organizational perspectives.

Table 2. Comparative summary of BIM–Geoinformation status in Malaysia and Turkiye

Aspect	Malaysia (Sarawak)	Turkiye
Legal Framework	Sarawak Land Code 1958, Strata Management Ordinance 2019, Native Customary Rights (NCR)	Civil Code, TAKBİS modernization, LADM pilot standardization
Primary Driver	Research-driven (UTM–Land and Survey Department collaboration)	Government-driven (TKGM, municipalities, national agencies)
Integration	BIM–LADM mapping	3D condominium

Focus	for strata and NCR land management	registration, cadastral modernization, and infrastructure mapping
Adopted Standards	IFC4, LADM (Sarawak Country Profile)	IFC, CityGML, LADM, XML for legal data
Database Platform	PostgreSQL/PostGIS; FME and IfcOpenShell integration	Centralized spatial database (PostGIS) with WMS/WFS web services
Challenges	Limited industrial awareness, semantic conversion issues, and legal adaptation	Harmonization of data formats, technical complexity, institutional coordination
Notable Use Cases	BIM–LADM integration for 3D strata management	Amasya and Yenimahalle 3D cadastre pilots, TAKBİS modernization
Readiness Level	Early stage (pilot research)	Intermediate stage (operational pilots and national strategy)

Both cases reveal that while Turkiye has achieved greater institutionalization through national-level BIM–LADM pilots, Malaysia's strength lies in its contextual adaptation to local legal and customary land systems, particularly within Sarawak's unique NCR framework. Turkiye's large-scale projects demonstrate the feasibility of LADM-based cadastral modernization, while Malaysia provides a model for localized BIM–LADM mapping applicable to heterogeneous legal environments.

The comparative findings suggest that both countries are transitioning from conceptual to operational stages. However, advancing interoperability, semantic enrichment, and georeferencing consistency remain shared priorities. Collaborative efforts, particularly in research exchange and standard harmonization, could accelerate regional progress toward full 3D land administration integration.

3. Issues

Integrating these two domains open up for several research and development opportunities as literature shows that they have different standards, requirements, and tools. Previous discussions indicated that, each country has different BIM policy (e.g., PAS 1192 in UK, BIM eSubmission in Singapore) which leads to lacking unified standards. Georeferencing is one of the issues for integration where BIM utilizes local coordinates and geoinformation based on geographic coordinates. Thus, the conversion of these two domains is compulsory for compatibility. Various works have been explored with some degrees of success; however, the issue remains to be investigated further. Other issues such as file formatting (e.g., BIM uses IFC while GIS relies on SHP), different data structures (different Level of Details), different databases and visualization.

The limited accessibility and awareness of BIM/IFC technologies, particularly among stakeholders outside the architecture, engineering, and construction sectors also part of the challenges. This restricts broader implementation and slows capacity building. In addition, interoperability and data conversion complexities between BIM and GIS formats remain a barrier to seamless integration, as differences in data models, semantics, and structures often require extensive manual intervention. There are also technical limitations related to semantic segmentation, which hinder the automation of BIM reconstruction and reduce data consistency when integrating different sources. Furthermore, current 3D GIS platforms offer limited support for time-series data, making it challenging to manage and analyse temporal changes in urban environments.

Normally, GIS software hardly reads IFC files. Thus, one of the solutions is to develop a program such as by utilising python tool (e.g., IfcConvert) from IfcOpenShell for the conversion of BIM/IFC file into a simple 3D GIS data format (e.g., obj, gltf). However, IfcConvert does not transfer the full semantic or attribute data, only basic geometry and some minimal data would be extracted. The scripting should be improvised for better visualization with details of the building's attributes. Other platform such as Feature Manipulation Engine (FME) also facing some issues in preserving all the IFC attributes. Even though FME can handle a wide variety of file types, the IFC reader is hard to extract and relate all attributes (Broekhuizen, 2021). Thus, an effective conversion of semantic information is crucial for supporting deeper analysis, querying, and decision-making processes in GIS platforms, and thus requires additional development beyond basic geometry extraction.

Another challenge is to ensure that the model is in IFC4 format when integrating with BIM and LADM. Basically, the raw data is initially in IFC2x3, which lacks certain attributes and capabilities required for seamless transformation and interoperability. Hence, the IFC model must be exported as IFC4 from Revit, ensuring both structural and architectural components are included. However, since Revit exports these components as separate files, they can be combined using IfcOpenShell, allowing for a unified representation of the building model before further processing.

Additionally, it is crucial to check metadata related to unit measurements (meters or feet). Since different datasets may use varying local Cartesian systems, proper identification and standardisation of units must be performed. This ensures consistency in spatial calculations and visualisation, preventing scaling errors or misalignment when integrating with other geospatial data sources. Addressing these challenges systematically will enhance the accuracy, interoperability, and usability of the BIM-to-LADM workflow within a 3D cadastral and web-based environment.

4. Conclusion

The preceding discussions warrant us to conclude that the BIM for Geoinformation requires more investigation and exploration especially in the aspect of elements filtering from huge BIM dataset. The filtering is one the ways to extract the useful elements which is crucial for creating information (e.g., 3D buildings / strata). This part of research still lacking in both countries although some works illustrates the potentials. Recent discussions also highlight the benefits of BIM-GIS integration such as 3D land administration. Interesting developments are being reported by several group of researchers within specialize conferences and workshops (e.g., FIG, ISPRS, 3DLA) as well as from academia / research institute. Current initiatives in both countries demonstrate growing awareness of the value of integrating BIM with geoinformation, particularly in the areas of 3D strata registration, cadastral modernization, and digital land administration. However, the integration remains challenged by issues related to interoperability, georeferencing, semantic conversion, and standardization between BIM and GIS domains. These challenges are not unique to Malaysia and Turkiye – they reflect global trends where legal, institutional, and technical factors often evolve.

Based on the findings, Malaysia represents a bottom-up innovation model, led by academic institutions, while Turkiye exemplifies a top-down implementation model, driven by government-led cadastral modernization. Recently, Malaysia Association of Authorized Land Surveyors (PEJUTA) initiates a brief BIM procedures and fees. These contrasting approaches provide complementary lessons for regional strategies in digital land administration. Malaysia's localized customization highlights the flexibility of LADM in diverse legal contexts, while Turkiye's centralized implementation underscores the importance of policy coherence and national data governance.

Looking ahead, both countries can benefit from mutual collaboration and knowledge sharing—particularly in developing standardized workflows for BIM–LADM mapping, improving data interoperability, and promoting open-source tools for semantic data integration. Establishing a joint Malaysia–Turkiye research framework under the ISPRS or FIG working groups could accelerate the development of interoperable 3D cadastral systems, contributing to the global agenda of transparent and smart land administration.

5. Recommendation

The integration of BIM and geoinformation in both Malaysia and Turkiye presents strong potential to enhance 3D land administration, urban management, and digital transformation in the built environment. Moving forward, several key areas could accelerate progress in both countries. Firstly, policy alignment and standardization are essential to support interoperability and ensure that BIM and geospatial data can be exchanged effectively. National guidelines and data standards that align with international frameworks such as IFC and LADM can strengthen this foundation.

Then, capacity building among surveyors, planners, land administrators, and technical professionals is critical to increase awareness and technical competency in BIM–GIS integration. This includes specialized training, workshops, and cross-disciplinary collaboration between academia, industry, and government agencies. Moreover, investment in research and technology is required to address technical gaps such as georeferencing, semantic conversion, and 3D legal spaces representation. Automation and open-source tools can help reduce reliance on manual processing and enable more efficient integration workflows.

Finally, international collaboration and knowledge exchange between Malaysia and Turkiye could accelerate innovation, allowing both countries to share experiences and co-develop frameworks for digital cadastre and smart land administration. This collaborative approach can serve as a regional model for BIM–Geoinformation integration, especially for countries facing similar challenges in legal frameworks and technical readiness.

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