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Proposal for introduction 3D object registration into the Polish legal framework

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Summary

The aim of this article is to answer the question whether it is justified to introduce the registration of 3D objects in the real estate cadastre in Poland, considering the scope of information registered in other countries. This aim requires the discussion of new legal and technical conditions that might be necessary to introduce the registration of 3D objects in the real estate cadastre in the light of the new proposed legal regulations in Poland.
The article presents the principles of functioning of the multidimensional cadastre in various countries. The research method includes both the analysis of literature on the registration of cadastral objects and the planned legal regulations. The research focused on the analysis of the scope of information and the method of registering objects in the real estate cadastre in Poland. The article presents a proposal to amend the geodetic legal and technical regulations concerning both objective and subjective data registered in the real estate cadastre and documents that form the basis for entries in the real estate cadastre. It takes into account the draft of the Layered Development Act, implemented in 2021–2022 at the De Republica Institute. The authors propose changes to the provisions in the existing legal regulations, which would enable the collection, processing, updating and sharing of information on 3D objects and their owners and other entities with the right to dispose of a separate space above or below the ground surface. In order to register 3D objects together with the right to them in accordance with the provisions of the draft Act, the authors recommend introducing the following entity: Zabudowca in EGB_StatusPodmiotuEwid, as well as a document used to disclose the scope of the 3D object, i.e. the decision to establish the right to develop in EGB_RodzajDokumentu.

Keywords

3D cadastre • 3D objects

1. Introduction

Currently in Poland, the development of urban agglomerations is limited by a lack of available space for investment. Space that could potentially be used for development is, among others, above or below existing facilities, e.g. various communication routes. Real estate often located in very attractive locations could be used for business activities, e.g. commercial or office.

There is certainly a need to introduce in Poland the right to space in a layered system, along with its simultaneous registration in the real estate cadastre. This problem concerns, among others, real estate built up with low-rise commercial facilities and communication routes. Free space could potentially be used to erect new buildings above the existing infrastructure or below the ground surface. Contemporary construction technology increasingly allows for the implementation of such investments. The obstacle to the implementation of such projects is therefore neither technology nor their economic unprofitability, but the lack of sufficient legal security.

The study aims to answer the following questions:

- Is it justified to introduce registration of 3D objects in the real estate cadastre in Poland, considering the scope of information registered in other countries?
- What changes to geodetic and legal regulations would enable the introduction of 3D object registration in the real estate cadastre in the light of the new proposed legal regulations in Poland?

The growing complexity of intensively urbanized areas, together with the implemented technical infrastructure, requires proper registration of the legal status of objects that are private property, as well as those belonging to the public sector – or the introduction of a new right to space. 2D representation fulfills the role of providing information about cadastral objects to a limited extent [Van Oosterom et al. 2016].

Full provision of 3D information, together with its practical implementation in cadastral systems, is a multidisciplinary problem. Elements such as legal basis, 3D measurements at the stage of investment initiation and after its completion, representation of 3D objects with their attributes together with visualization show that there is a constant need to conduct research on the registration of 3D objects together with the rights to them. Peter van Oosterom et al. [2016] emphasize that this development is visible in the work carried out within specific disciplines, as well as between disciplines. This results in the creation of operational systems dealing with land management and administration as 3D objects.

Dogus Guler [2024] emphasizes that the real estate cadastre is one of the registers that collects data on various objects located underground and above ground on plots of land. The view on the proper management of the underground part of plots is shared by Matuk [2019], Perperidou et al. [2021], Ramlakhan et al. [2023]. On the other hand, Zhang et al. [2020] presented proposals that directly affect the improvement of real estate management and the registration of cadastral objects implemented in the urban space below the ground surface. Research was also conducted on the registration of the right to use a 3D object as a property right. The analysis of various legal regula-

tions functioning in the European Union (EU) shows that it is necessary to have legal regulations that take into account the right of ownership to objects implemented on, under and above the surface of the ground, including metro tunnels [Karabin et al. 2020, Matuk 2019]. This may facilitate the functioning of 3D underground real estate registration.

The use of underground space can be adopted in the context of sustainable development and management of urban agglomeration [Cui et al. 2021, Hunt et al. 2016, Parker 1996].

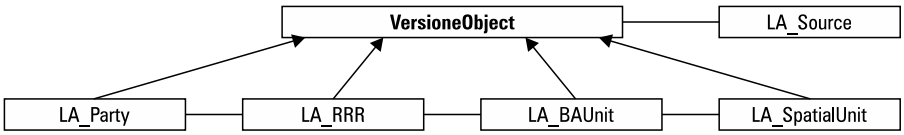
The most commonly used standards for 3D object registration are LADM, CityGML and IFC [Guler et al. 2022, 2022a, Gürsoy Sürmeneli et al. 2022, Atazadeh et al. 2021, Atazadeh et al. 2017, Cagdas 2013]. Ploeger and Stoter [2004] undertook to present a proposal for the registration of technical infrastructure objects. The 3D registration of cadastral objects related to underground technical infrastructure was proposed in order to develop a modern cadastral system registering 3D objects [Kim et al. 2017, Yan et al. 2019]. The scope of data, including attributes, about 3D objects depends on the needs of users [Pouliot et al. 2015, Pouliot et al. 2016]. Kim et al. [2017] and Saeidian et al. [2022] focused on the development of conceptual models based on the LADM standard for cadastral registration and presented 3D modeling of various underground objects, such as underground utility networks [Budkowski et al. 2023a, b, Radulović et al. 2019, Yan et al. 2021, 2019], underground winery [Janečka et al. 2018] and underground metro tunnel [Matuk 2019]. An important aspect of 3D object research is the creation of a three-dimensional plot. This was attempted by Perperidou et al. [2021] who developed a spatial plot of the Piraeus metro station in Greece. Ramlakhan et al. [2023] mapped the object features in the LADM standard in the IFC schema and showed a three-dimensional representation of the utility network space. Also for the needs of three-dimensional 3D space modeling, an extension of the CityGML 3.0 schema was developed along with the presentation of the functionality of the schema in the form of visualization using the CityGML file [Saeidian et al. 2023b].

The ISO 19152 'Geographic information – Land Administration Domain Model (LADM)' is a descriptive standard. It provides a reference model to be used as a basis for the development and improvement of effective systems for broadly understood real estate administration based on MDA technology (Model-driven architecture). It enables interested parties to communicate through a standardized vocabulary introduced by the standard.

The Cadastral Land Administration Model, as a product, is a conceptual scheme, which uses the class diagram formalism, written in the Unified Classification Notation Modeling Language (UML). LADM is based on six basic classes, all of which are inherited from Versioned Object:

1. The LA_Party class, whose instances, i.e. objects created based on a given class, are parties (entities).
2. Class LA_RRR. Instances of the LA_RRR subclasses are rights, restrictions, or responsiblities.

3. Class LA_BAUnit. Instances of this class are basic administrative units, i.e. sets of spatial elements.
4. Class LA_SpatialUnit. Instances of this class are spatial elements.
5. VersionedObject class. This class is an abstract class, and instances of VersionedObject subclasses are all LADM classes (except LA_Source and its subclasses).
6. Class LA_Source. Instances of this class are sources, i.e. administrative and spatial.



Source: Authors' own study based on the LADM standard

Fig. 1. Basic classes of the core LAND

In Poland, there is a separate registration of cadastral objects, i.e. plots, buildings and premises constituting a separate real estate in the real estate cadastre, and a separate registration of rights to real estate in the land and mortgage registers.

In the light of the legal regulations in force in Poland, buildings and premises may constitute separate real estates. A building situated on a cadastral plot may constitute a separate real estate, and premises located in the body of a building may constitute a separate real estate [Bieda et al. 2020]. Information about objects is included in the real estate cadastre, but data on their location is in the orthogonal coordinate system, including the physical and legal status of cadastral objects. The only reference to three-dimensional space can be considered as descriptive information regarding the number of underground and above-ground levels [Bydłosz et al. 2020a].

Proposals to extend the registration of the Polish cadastre have been a subject of many discussions. Siejka et al. [2014], Sanecki et al. [2013], Karabin [2013], Góźdź et al. [2014, 2014a], Matuk [2019], Bydłosz [2013, 2018], Bydłosz et al. [2013, 2020] proposed to extend the functionality of the cadastral system in Poland for new 3D objects. Three-dimensional plots have been represented as classes EGB_CadastralParcel3D and EGB_BuildingLegalSpace3D. The proposed model allows the representation of a 3D plot as an object above ground, underground, or as a combination of both.

The registration of an object belonging to the EGB_BuildingBlockUnderground3D class proposed by Bydłosz et al. [2020] determines the registration of this object using attributes. The authors indicate that most of them will be similar to those of ground objects. However, due to the specificity of underground objects, it is suggested to save information about their geometry in the 3D cadastre database. One of such attributes is the 'contour type' attribute, which specifies what kind of solid we are dealing with. The methods of obtaining information about the building contour may vary, because we can perform measurements of both external and internal contours. Direct measurement

of the external contour would be the most desirable. Therefore, Bydosz et al. [2020] proposed distinctions of the 'contour source' for EGB_BuildingBlockUnderground3D objects. In practice, new underground objects are often created as a result of tunneling, e.g. the metro. For historical objects that are often explored from the inside, Bydłosz et al. [2020] suggest entering data from direct interior measurement into the 3D cadastre database. Alternatively, the geometry of the external contour can then be additionally obtained from the construction documentation, if it has been preserved, or using modern measurement methods.

2. Data and methods

The subject of the research is the registration of objects functioning in four countries: Poland, Germany, Sweden and Canada. The study used an unofficial draft of a legal act entitled 'the Layered Development Act' implemented in 2021–2022 at the De Republica Institute. The features characterizing the new right to space, i.e. layer law, which have an impact on the proposed geodetic and legal solutions for the functioning of the real estate cadastre in Poland, were indicated.

2.1. Study of 3D object registration in selected countries

The study covered cadastral systems regulated in legal acts functioning in four countries: Poland, Germany, Canada and Sweden in order to answer the question whether it is justified to introduce the registration of 3D objects in the real estate cadastre, considering the scope of information registered in other countries.

With respect to Poland, the subject of the analysis was the Act of 17 May 1989 – Geodetic and Cartographic Law (consolidated text: Journal of Laws of 2024, item 1151) and the Regulation of the Minister of Development, Labour and Technology of 27 July 2021 on the land and building register (Journal of Laws of 2021, item 1390), the Regulation of the Minister of Development, Labour and Technology of 23 September 2021, amending the regulation on the land and building register (Journal of Laws of 2021, item 1781), the Regulation of the Minister of Development and Technology of 15 March 2023, amending the regulation on the land and building register (Journal of Laws 2023, item 745) and the Act of 23 April 1964 – the Civil Code (consolidated text: Journal of Laws of 2024, item 1061, 1237).

In relation to Germany, the subject of the research were the legal acts Grundbuchordnung (GBO), Grundbuchverfügung (GBV), Vermessungs- und Katastergesetze, Einführungsgesetz zum Bürgerlichen Gesetzbuche (EGBGB), Amtliches Liegenschaftskatasterinformationssystem (ALKIS).

The legal acts in force in Sweden that were the subject of the study are Jordabalken, Fastighetsbildningslagen, Lantmäteriet.

The Land Titles Act, Strata Property Act and Registry Act in Canada were also the subject of the research.

Table 1. Real estate cadastre in selected countries

Category	Poland	Germany	Sweden	Canada
Technologies used to update the cadastre	Data from geodetic measurements	GIS systems, i.e. Geographical Information Systems, 3D models, LiDAR data	GIS, i.e. Geographical Information Systems, 3D models, geodetic measurement data	GIS, i.e. Geographical Information Systems, 3D models, photogrammetry, LiDAR data
Responsible bodies	Geodetic and Cartographic Service	Federal Ministry of the Interior, Construction and Community (BMI), geodetic staff	Lantmäteriet, i.e. the Swedish Land Surveying and Cadastral Agency	Provincial governance, such as the Land Title and Survey Authority of British Columbia (LTSA)
Presentation 3D objects for cadastral map	2D	2D	2D – there are special symbols for property units associated with 3D objects.	2D plan with description, to which complementary PC plans refer. PC plans show vertical profiles and division plans of each floor. They contain information about the height and volume of the object shown.
Type cadastral plot (2D/3D)	2D	2D	3D	2D
Registered objects	The real estate cadastre registers land, buildings and premises along with the rights to them. It does not certify the legal status of real estate.	The real estate cadastre is the official register of real estate. It registers the location of plots, buildings and describes their properties. It does not describe the factual and legal status of the land.	3D property is defined as a unit of property that is bounded both horizontally and vertically in its entirety. A 3D property may include properties with different functions, e.g. premises consisting of several apartments or offices, service premises. Often a 3D property also consists of objects, e.g. tunnels or other objects implemented under the surface of the ground.	Real Property means the term includes land, buildings and other structures permanently attached to the land. In some provinces, e.g. British Columbia. There is a Strata system that regulates the ownership of multi-level properties.

The scope of registered rights to objects	The right to a plot of land extends within the limits defined by the socio-economic purpose of the land; ownership of the land extends to the space above and below its surface. This provision is without prejudice to the provisions governing water rights.	Ownership rights can include both land and buildings. The 3D concept is also being introduced, which allows for separate ownership rights to different parts of a building (e.g. floors).	The ownership right can include both land and buildings. After the introduction of the 3D-fastighet system, it is possible to have separate ownership rights to specific three-dimensional spaces, e.g. floors, underground parking lots.	Property ownership includes land and buildings. In the Strata Property system, it is possible to own separate units (e.g. floors, apartments) in multi-story buildings, independently of the land.
Property boundaries	Property boundaries are defined in two dimensions at ground level.	Property boundaries are defined in two dimensions at ground level.	Property boundaries are specified in both two dimensions and in three dimensions as a 3D object, which has been the standard since 2004.	Property boundaries are primarily defined in two dimensions, but in some provinces (e.g. British Columbia) the Strata Property system allows boundaries to be defined in three dimensions (vertical space).
Horizontal division of real estate	No	Yes, it is possible via a 3D cadastral system which allows you to define separate parts of a building (e.g. floors).	Yes, fully possible within the 3D-fastighet system, which allows you to have different parts of the building on different levels, e.g. floors, underground spaces.	Yes, possible with the Strata Property system, which allows you to have separate units in multi-level buildings such as apartments, offices, etc.

2.2. Analysis of the unofficial legal act – the Layered Development Act

The basic features of the proposed legal act – the Layered Development Act – were extracted from the draft.

Table 2. Features of the Layered Development Act

No.	Selected features of the Layered Development Act resulting from an unofficial draft legal act
1.	The right to 3D space is transferable, inheritable and enforceable.
2.	The developer is an entity that has the right to build a layered building.
3.	The right to 3D space can be mortgaged.
4.	A structure, building, construction device or other construction object erected by an entity possessing the right to layered development within the scope of the right to layered development is its property.
5.	The method of using the real estate by the entity holding the layered right is specified in an agreement on the establishment of the layered development right in the form of a notarial deed.
6.	The right to layered development arises upon entry in the land and mortgage register.
7.	The right to build a layered development is a temporary right, i.e. it may be established for a period not longer than 99 years.
8.	Objects that are entitled to layered development rights are registered in the real estate cadastre.
9.	The voivode, at the request of the owner of the real estate or the entity for whose benefit the right to layered development is to be established, issues, in the form of an administrative decision, consent to the establishment of the right to layered development.
10.	The scope of the development right is determined by the investor in the decision of the Voivode.

It should be emphasized that the primary goal of the new regulation on the layer law is to take into account the interests of all interested groups of entities, i.e.: investors, property owners and people who use urban space. The draft of the unofficial legal act meets the above requirements.

2.3. Registration of objects in databases

The real estate cadastre basically registers objects in two dimensions. Only the above-ground and underground layers are registered using the appropriate attributes as objects. The cadastral model itself and its graphical representation are limited to the X and Y dimensions.

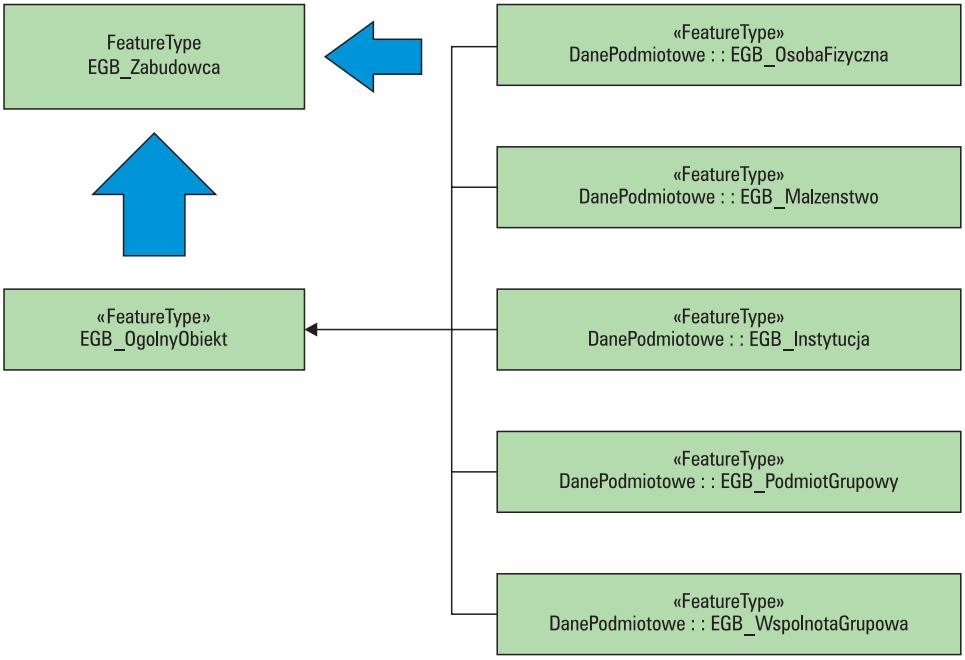
The detailed scope of real estate cadastre data is specified in the Regulation of the Minister of Development, Labor and Technology of July 27, 2021 on the land and building records [2021]. The UML application schema for EGiB data is presented in

multiple diagrams: general object, inheritance, object data, subject data, grouping JR and entities, shares, subject address, real estate address, border point, legal basis, graphical presentation.

Information in the diagram: subject data concern EGB_CadastralPlot, EGB_Building, EGB_ObjectPermanentlyAttachedToBuilding, EGB_BuildingBlock, EGB_IndependentPremises, EGB_AreaBelongingToPremises, which are registered depending on the subject of registration in EGB_LandRegistrationUnit, EGB_BuildingRegistrationUnit, EGB_PremisesRegistrationUnit.

The diagram does not include the registration of separate spaces above and below the ground surface as a separate 3D object.

Diagram: entity data describes the relationships between disclosed entities within EGB_OgolnyObiekt.



Source: Authors' own study

Fig. 2. Fragment of EGB_GeneralObject diagram: inheritance modified by authors

The content of the diagram: it contains the bases for changes to entries in the real estate cadastre, i.e. EGB_OpertaTechniczny and EGB_Dokument (Table 3). From the point of view of changes introduced in the real estate cadastre, among EGB_Dokument, we distinguish EGB_RodzajDokumentu. It should be noted that «Enumeration» EGB_DocumentType does not include documents defining the scope of a 3D object resulting from administrative decisions.

Table 3. EGB_DocumentType registered in the real estate cadastre

«Enumeration» EGB_DocumentType	«Enumeration» EGB_DocumentType
contractNotarial Deed = 1	regulation = 13
landownership deed = 2	resolution = 14
decisionAdminOtherNonAWZ = 3	order = 15
Court rulingDecisionSentence = 4	extract from another public register = 16
extractFromLandRegister = 5	power of attorney = 17
extractFromMortgageBook = 6	otherDocument = 19
copy of KW file or document collection = 7	ArchitecturalBuilding dok = 20
notificationFromKW Department = 8	PlanningDoc = 21
changerequest = 9	inheritancecertificate act = 22
excerptFromBuildingConstructionDocumentation = 10	notificationZPESEL = 23
protocol = 11	notification of change of use = 24
Act = 12	

3. Research and research results

The analysis of the draft legal act entitled 'the Layered Development Act' implemented in 2021–2022 showed that changes in the geodetic and legal regulations should include in particular:

- Expanding the scope of information on land and entities disclosed in the land and building register.
- Inclusion of the obligation to report changes in data on the separate space above or below the ground surface by entities with the right to dispose of a separate space above or below the ground surface, as well as courts, public administration bodies, notaries and other authorized entities.
- Creating a legal basis for sharing data from land and building records with a separate space above or below the ground surface.
- Expanding information on the development and transfer of results of geodetic situational and elevation measurements to the state geodetic and cartographic resources.

The study of cadastral object registration in selected countries showed that Poland does not have 3D object registration. In Germany, however, there is 3D registration of objects with rights related to parts of buildings. Sweden has 3D object registration. Different levels of real estate are distinguished with rights related to separate spaces. A similar principle operates in some provinces of Canada, i.e. there is layered registration of the surface above and below the ground surface.

Studies have shown that it is reasonable to introduce 3D registration in Poland. This would allow for the registration of 3D objects with the right to a separate space with the right to it.

In order to register 3D objects, it is necessary to extend the registration of subject data and the scope of documents forming the basis for changes to entries in the real estate cadastre. In terms of introducing 3D registration in accordance with the draft legal act entitled 'the Layered Development Act', the solutions proposed by Bydłosz et al. [2013, 2020], Bydłosz [2018], can be adopted as the basis. These solutions require only minor adjustments. Subject registration should be extended to include an additional entity – EGB_Zabudowca (Fig. 2) – and the additional documents necessary to disclose changes to entries in the real estate cadastre, including decisions on the establishment of the right to development, which includes an indication of the space together with the Layered Development Act.

Based on the research conducted on the registration of 3D objects in the analysed countries and the draft of an unofficial legal act, the Layered Development Act, it is proposed to change the provisions of the legal acts regulating the maintenance of the real estate cadastre in Poland, which would enable the information system to collect, process, update and provide information on:

- a separate space above or below the ground surface,
- owners and other entities along with their place of permanent residence or the address of the registered office of entities that have the right to build layered buildings above or below the ground surface.

It would be necessary to introduce an obligation for entities with the right to dispose of a separate space above or below the ground surface to submit the required legal documents that constitute the basis for changes affecting the updating of information contained in the land and building register.

Also, the District Officer's responsibilities should be expanded in the scope of providing data from the land and building register and with regard to issuing extracts from the cadastral report containing objective and subjective data. Changes to the regulations in this scope will authorize the District Officer to provide data on a separate area. This document will be able to constitute the basis for introducing changes to the content of the land and mortgage register.

4. Conclusions

The introduction of a new concept of 'layer law', which is registered in the real estate cadastre, into the Polish legal system should take into account the interests of entities looking to acquire such a right to build up a property, as well as property owners willing to make part of their land available for development in order to make a profit. The potential benefits of introducing 3D object registration together with the right to separate spaces is the wider use of properties that are currently intended solely for the needs of transport infrastructure or by low-rise buildings. The study showed that 3D object registration functions in other countries and allows for the registration of objects with the rights to them. Such a solution could also be implemented in Poland with minor changes in legal regulations and in the applicable databases. The article proposes the

extension of legal and technical regulations concerning cadastral data. It introduces the concept of a new cadastral entity – 'Developer', and a document enabling the registration of the scope of a 3D object, i.e. a decision on the right to layered development. The recommendations are consistent with the draft of the Layered Development Act developed in 2021–2022 at the De Republica Institute.

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