

SELECTED LEGAL ASPECTS OF THE 3D CADASTRE – A COMPARATIVE STUDY OF POLAND AND SLOVAKIA

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Summary

The real estate cadastre, understood as a public register and a legal institution, has since ancient times guaranteed legal certainty in property transactions and the implementation of fiscal objectives related to the collection of taxes. Over time, new tasks have been assigned to the cadastre. Reports published by international organizations such as the International Federation of Surveyors (FIG) and the United Nations (UN) have revealed the shortcomings of existing legal systems in the management of land administration rights, restrictions and obligations. In this context, the paper presents a polemic on the possibility of implementing a multidimensional cadastre in Poland and Slovakia. The most important milestones in the evolution of the land administration system in both countries were reviewed and the possibility of implementing layer ownership was discussed. The aim of this publication is to conduct a comparative study with a view on research on the applicable legal regulations in the context of the possibility and legitimacy of the implementation of the multidimensional cadastre in both countries. The research method used is a case study. It was supported by an analysis of legislation in the above-mentioned scope and a field interview. The research carried out as part of the comparative study clearly indicates the legitimacy of introducing the registration of layer ownership. The type of legal systems in Poland and Slovakia will have a significant impact on the degree of complexity of the multidimensional cadastre implementation process.

Keywords

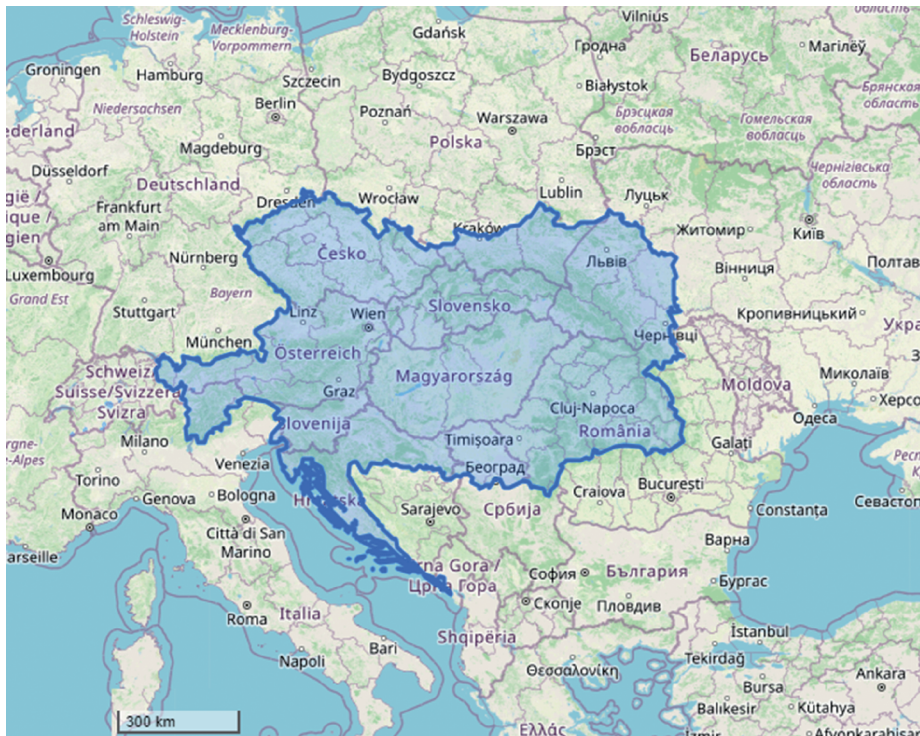
land and building register • 3D cadastre • ownership • spatial plot

1. Introduction – research issues

Since ancient times, mankind has been involving in collecting and registering various types of information on real estate. The first mentions of keeping such registers come from ancient Egypt, China and the peoples living in the Fertile Crescent of Mesopotamia [Fedrowski 1974]. Of all the countries of the ancient world, Egypt stood out in terms of administrative skills and management. It excelled in land surveying and compiling registers, which were the basis for taxation. Julius Caesar's victorious military expedition to Egypt and the enactment of land tax legislation were the next stage in the development of the land register. The Roman Empire tax system at the time needed

to be tightened. This became an impetus for a reform that ended during the reign of Emperor Augustus, who is officially recognized as the creator of the Roman cadastre [Zachariasz 2007]. The tax on land (*tributum*), unlike during the times of Julius Caesar, was paid entirely in cash. The amount of *tributum* was not related to the property qualification, but was calculated based on the area criterion. The term 'cadastre' was created in ancient Rome during the reign of Octavian Augustus in result of merging the tax unit (*caput iugum*) and the census (*capitum register*) into one word, *capitastrum* [Joer et al. 1904]. The fall of the Roman Empire at the end of the 4th century served as a brace for the dynamically developing cadastre.

Another impulse for the development of the cadastre occurred during the reign of the Habsburgs, who sought to remove the remnants of the federal state, in favor of full centralization of power and creating a modern administration in the territories incorporated into the monarchy [Wnek 2011]. The administrative growth of the state, as well as costly war campaigns, led to an increase in the fiscal burden on the subjects. In terms of keeping the land register, this period was largely the same for both Poland and Slovakia, due to the fact that the entire territory of today's Slovakia as well as the southern borders of the then Polish-Lithuanian Commonwealth belonged to one state (Fig. 1).



Source: own studies based on <https://maps.geshergalicia.org/datamap> [accessed: 13 August 2023]

Fig. 1. Administrative borders of Austria-Hungary compared to the countries of today's Europe

After World War II, each country chose its own way of operating the land and building register. The aim of this publication is to conduct a comparative study with a view on research on the applicable legal regulations in the context of the possibility and legitimacy of the implementation of the multidimensional cadastre in both countries.

2. Materials and methods

According to reports published by international organizations, such as the International Federation of Surveyors (FIG) and the United Nations (UN) [UN-FIG 1996, 1999], legislative solutions did not keep up with the dynamic development of infrastructure and limited the management of rights assigned to real estate. The vision of the cadastre of the future, according to the reports, concerns primarily highly urbanized and industrialized areas. The main task of the cadastre will be to demonstrate the comprehensive legal situation of land, taking into account the rights or possible restrictions in the field of spatial ownership of property. There were attempts to meet this demand for research activities over the last 20 years in many countries in Europe and the world that demonstrated various concepts and possibilities of implementing vertical spatial registration solutions [Rahman et al. 2015, Zamzuri and Hassan 2021, Li et al. 2021, Atunggal et al. 2021, Atazadeh et al. 2021, Stoter et al. 2019, Alkan and Sumeneli 2019, Doner 2021, Paasch and Palusson 2021]. The starting point for the considerations in Poland and Slovakia was the first meeting of the FIG in Delphi in 2001, which resulted in many pilot projects related to the rights, organization and technical aspects of the 3D cadastre [Karabin et al. 2021, Budkowski et al. 2022, Budkowski 2020, Budkowski and Litwin 2018, 2019, Raskovic et al. 2019, Buško et al. 2022]. This paper follows this trend and also fills an important gap in the field of applying a comparative approach by countries aspiring to implement a multidimensional cadastre. An important argument is also the fact of having common land registers in the past. The research method used is a case study. The method was supported by an analysis of legislation in the above-mentioned scope and a field interview. The assumed research hypothesis says that the differences in the legal systems of Poland and Slovakia will have a significant impact on the degree of complexity of the multidimensional cadastre implementation process.

2.1. Slovak cadastre

According to the current law in Slovakia, Act no. 162/1995 Col. [Act 1995] on the real estate cadastre and on the records of ownership and other rights to real estate, the registered objects are: parcels, buildings, underground structures, flats and non-residential premises under construction. In the Slovak cadastre, unlike in the land and building register in Poland, the principle of *'superficies solo cedit'* does not apply, which means that each existing building with a foundation is a separate property. Underground structures are registered at the points of their intersection with the earth's surface. The Slovak cadastre distinguishes the cadastral parcel as the basic unit of the cadastral division of land [Act 1995]. A parcel should be understood as an area of land defined due to its geometry

and shape, having its own individual number and graphic representation on the cadastral map. The Slovak legal system distinguishes 'C' and 'E' parcels. Pursuant to the [Act 1995] data on parcels C are recorded on the cadastral map and their boundaries are clearly visible in the field. Parcels E are the product of historical events related to the process of collectivization of agriculture, which is why they are usually merged into larger units. The rights related to the parcels E and the course of their borders in accordance with Article 70 section 162/1995 [Act 1995] 'are not binding cadastral information.' Parcels are numbered with natural numbers, and newly created parcels have the form of a fraction the denominator of which is a natural number. Within a cadastral area, the basic reference system is the parcels from the C register. In the Slovak cadastre, buildings are a subset of the C parcels. Each building is built on one or several C cadastral parcels, and there may be several buildings on a parcel. The buildings are graphically presented as parcels C on which they are built. Therefore, buildings are not separate objects in the cadastral system and do not have a separate layer assigned to them. The situation is similar in the case of premises and other building objects (slender objects), which are registered only descriptively and do not have a geometric representation on the cadastral map [Kysel and Hudecova 2022, 2021, Buško et al. 2022].

2.2. Register of land and buildings in Poland

According to the law currently in force in Poland, the legal acts regulating the land and building records are: *the Geodetic and Cartographic Law* [PGiK] and, as an executive act, *the regulation on land and building records* [egib]. According to the definition, *the register of land and buildings (real estate cadastre) is a uniform for the entire country, systematically updated collection of data on land, buildings and premises, their owners and other legal persons holding these lands, buildings and premises.* The legal status of real estate is disclosed by land and mortgage registers, which are regulated by *the Act on Land and Mortgage Registers and Mortgages* [UKW]. Therefore, the duality of the register is not only formal but also institutional, since land and building registers are kept by the county authorities, and the land and mortgage registers by the land and mortgage register courts. The basic units of land division are the cadastral unit, the cadastral precinct and the cadastral parcel. A parcel is a continuous area of land located within one precinct, uniform in legal terms, separated from space by boundary lines. Under the current legal solutions, the parcels are counted in natural numbers, but after the parcel is divided, a denominator is added, which is the smallest free natural number (within a given parcel) that allows the divided parcels to be distinguished. Parcels contain two-dimensional geometric data as well as descriptive data such as: parcel identifier, surface area, land and mortgage register number and land marking confirming ownership. In the case of buildings, the numerical description of the building contour is recorded together with descriptive attributes such as: building identifier, number of above-ground and underground storeys, and surface area. The land and building register in Poland also provides for the registration of premises. However, it should be emphasized that the premises listed in it do not contain information about

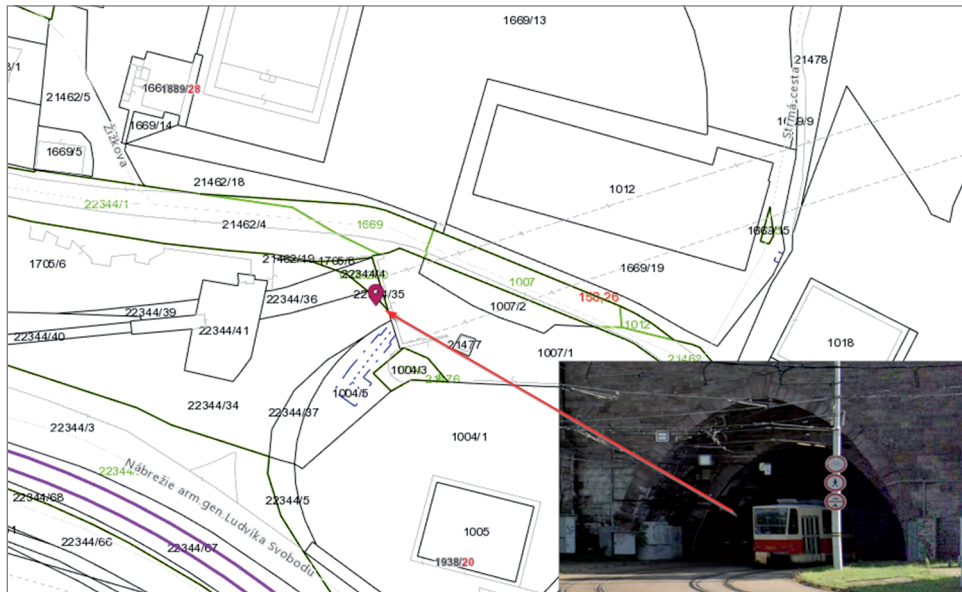
geometry, but only descriptive information. In addition, only independent premises that are disclosed on the basis of a starost's certificate should be included in the register [egib, PgiK, Bacior 2023].

2.3. Registration of objects in practice

The dynamic development of infrastructure translates into the need for more effective management of space. Increasing the density of real estate requires the establishment of rights that bind not only horizontally but also vertically, and the current registers in both countries do not always accurately represent the objects. In order to verify this hypothesis, examples of objects from Slovakia (Bratislava) and Poland (Krakow) will be analyzed.

Registration of underground objects

- In the Slovak cadastre, the outline of underground buildings is shown in the places where the entrance of the object intersects with the ground surface. This information usually applies to underground buildings and basements. However, other facilities such as a subways, tunnels, garages or underground warehouses (subject to separate ownership) do not need to be registered and thus are not included on the cadastral map (Fig. 2).



Source: Authors' own study

Fig. 2. Entrance to the tunnel at Generala Ludvika Svobodu Street on the cadastral map and in the photo

- In the case of registering buildings in Poland that only have underground storeys, the building area is calculated on the basis of a rectangular projection on the horizontal plane of the external edges of the building. Similarly to Slovakia, the cadastral map does not show objects such as tunnels or bridges, which have a different scope of ownership in vertical terms. It can be noticed that the yellow color shows the land owned by the Municipality of Krakow that has been transferred to other forms of ownership. Meanwhile, the land owned by the State Treasury that has also been transferred to other forms of ownership is in pink. The conducted analysis proves that on a two-dimensional map it is not possible to capture the complex ownership relations of the Grunwaldzki Bridge located directly on the Vistula River, which is owned by the State Treasury. In addition, an analogous situation occurs in the case of the tunnel under the Grunwaldzki roundabout, as the 2D map cannot accurately represent the full extent of the assigned rights (Fig. 3).



Source: Authors' own study based on the Krakow Observatory

Fig. 3. Rondo Grunwaldzkie in Krakow, ownership structure and site plan

Registration of atypical building objects

- The Octopus Habitant housing complex located on Zahradnicka Street in Bratislava is an example of a modernist building. On the Slovakian cadastral map, the buildings are represented by the parcel they occupy. It is impossible to reserve a separate layer for the representation of building objects on a two-dimensional map.

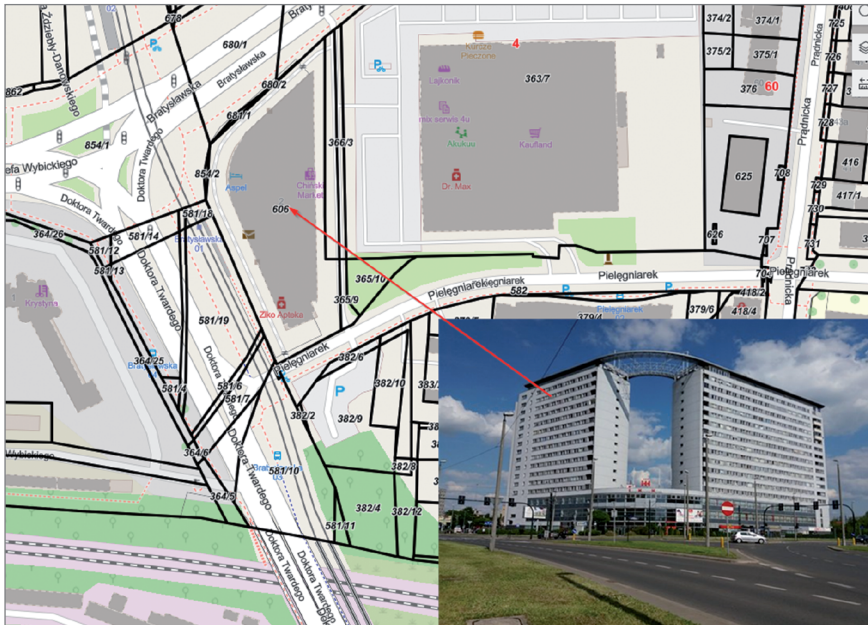
The presentation of the accurate extent of rights assigned to the object is equally problematic. In addition, from the legal point of view, those parts of the building that extend beyond its outline and occupy space above the land that is the subject of separate ownership may also be important. For example, a fragment of the building on the lot 15295/110 is situated directly above a café, above which there is an element connecting the buildings. Registration of such spaces may also be problematic due to the attempts to assign functions to buildings that are inconsistent with their actual use. Another problematic issue may occur in the case of registration of descriptive attributes, such as the number of storeys of a given building, which is basically different for each of the walls of the building (Fig. 4).



Source: Authors' own study

Fig. 4. Octopus Habitant residential complex at Zahradnicka Street in Bratislava

- An example from Poland is the building of the Aspel hotel in Krakow, which cannot be correctly represented on a two-dimensional map due to its, as in case of the building from Bratislava, non-standard shape. As shown by the photograph, the central part of the building has a different number of storeys than the rest. The building itself, however, is a uniform solid whose outline in the XY plane, together with the supplemented descriptive attributes, does not properly reflect the shape of the solid. The question in this case is how to determine the height of the building, and thus enter the correct number of storeys as a descriptive attribute (Fig. 5).



Source: Authors' own study based on the Krakow Observatory

Fig. 5. The building of the Aspel hotel in Krakow at Bratyslavska Street

Registration of rights related to real estate

- In the case of the cadastre kept in Slovakia, all kinds of encumbrances on real estate can be established on the basis of a civil law contract, a court decision or an administrative decision for the benefit of a transmission company. The owner is entitled to a one-time compensation for the establishment of the easement and limited use of the land corresponding to the degree of limitation. Easements established on real estate do not expire upon sale and remain attached to the property. The scope of easement is always legally defined and dedicated by a legal norm. For example, for overhead lines, it reaches a distance of 20 meters from the outer wires of the line. If the scope of permissions is not defined by law, the limitation occurs within the real location of the transmission device. These rights have been presented on a separate vector layer since 2009. However, it should be taken into account that this applies in particular to new facilities built after that date [Hudecova and Geisse 2018].
- In Poland, there is no legal obligation to show land easements and other rights encumbering real estate in the land and building records database. Established easements are entered in section III of the land and mortgage register for real estate encumbered with a limited right in rem and presented on maps for legal purposes. Information about the entry of an easement also appears in section I of the land and mortgage register, similarly as information on the rights related to the dominant

real estate. The descriptions of the easement do not always precisely define its exact range, especially with regards to its spatial nature.

3. Findings

As part of the work, the legislation in Poland and Slovakia was also analyzed along with a proposal to implement changes in the context of the possibility of implementing a multidimensional cadastre in these countries. The results of the research are presented in Table 1.

The research carried out as part of the comparative study clearly indicates that the introduction of the registration of layer ownership would be beneficial. Both in Poland and Slovakia, one can easily find situations in urban spaces where the representation of ownership relations on two-dimensional maps is not possible. The conducted analysis demonstrates that it is also necessary to diagnose the need not only for the current, correct registration of objects and ownership relations, but also for the investment potential related to the introduction of vertical ownership. It should be noted that the implementation of the 3D cadastre would involve the management of 'virtual spatial parcels', which could be the subject of economic trading and could potentially finance investment plans. Layered ownership in the legal systems of both countries could have a positive impact not only on the possibility of real estate registration in accordance with the facts and law, but also in the aspect of investments. Considering that neither Krakow nor Bratislava have a metro system, and both cities have previously expressed their interest in such investment, the proposed solution may prove useful.

Regardless of the country, the introduction of stratified ownership should be based on the land administration domain model (LADM), which is a hierarchical, international standard that can stimulate application development and accelerate the implementation of land management systems supporting sustainable development goals. LADM includes the basic information components related to land administration, referring to entities, objects, administrative units, while also taking into account the geometry, topology and attributes of objects. According to the authors of the paper, the vision of the cadastre of the future should be extended to include the IFC standard used in BIM modeling. The IFC standard in its current form does not allow for the legal management of information related to real estate, but its proposed modification (Fig. 6) could be helpful in determining the extent of rights that constitute an encumbrance for real estate, such as utility transmission easements. Proposed modifications include: creation of spatial zones (`IfcSpatialZone`) to which rights can be assigned; in the field of attributes, assigning the `IfcSpatialZoneTypeEnum` attribute, with the option of choosing the type of right, introducing the `IfcRelSpaceBoundary` relation that makes it possible to define the border directly on the edge of the object or regardless of the edge course. The proposed changes suggest the potential to continue research in the future, and the obtained results have significant implications for the development of the discussed research area.

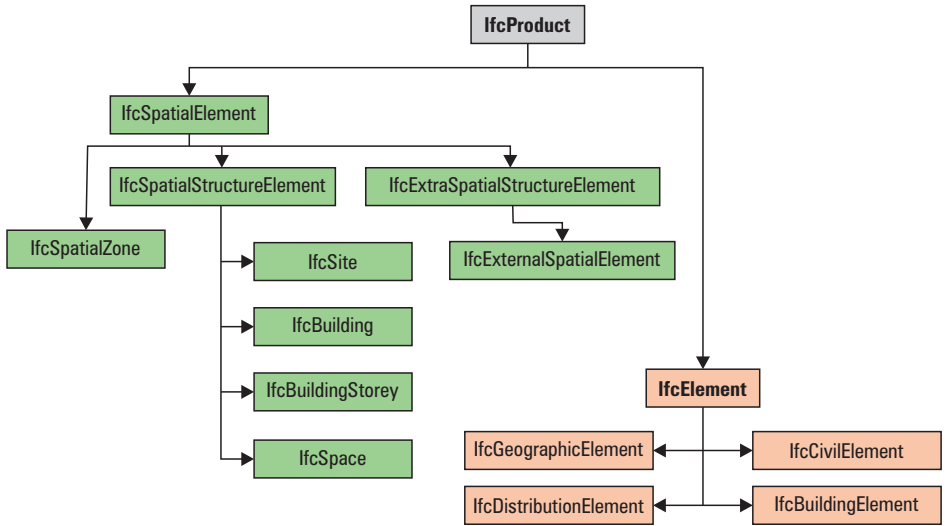
The results recorded in the property are presented in Figure 7.

Table 1. Summary table of the current state of registers and proposed solutions

Problem definition	Poland	Slovakia	Proposed solutions
How to keep the register	Registration of rights in 2D space with institutional division: county office/land and mortgage register courts. The register is kept as a land and building register. The registered objects are parcels and buildings in the graphic scope and some premises in the scope of descriptive data	Registration of rights in 2D space without institutional division. The register is kept as a real estate cadastre. The registry includes parcels with and without buildings. The register lacks graphical information about buildings and premises	Poland: introduction of a nationally uniform register as a cadastre covering parcels, buildings and premises in the descriptive and graphic form. There is a need to unify the system of land and mortgage registers and units maintaining the cadastre. Postulated registration of 3D objects. Slovakia: Supplementing the register with graphical and descriptive representation of building and premises data (individual identifiers and feature layers). There are no institutional changes. Postulated registration of 3D objects
Encumbrances on real estate (easements)	The rights are described in section III of the land and mortgage register, presented on maps for legal purposes	The law is descriptive. Easements are presented on separate layers of cadastral vector maps (2D)	Poland and Slovakia: Obligation of spatial record
Protection of the legal status	No warranty in the IO KW department, Easements can be established on the basis of a civil law contract, a court ruling or an administrative decision. In the case of transmission devices, easements are presented on maps for legal purposes and entered into section III of the land and mortgage register	No warranty regarding the plot area. Easements can be established based on a civil law agreement, court ruling, or administrative decision. In the case of transmission devices, they can also be established based on binding law, and the scope of the easements is defined by law. (Almost every type of transmission device is regulated through a dedicated legal standard). The property owner is informed about the registration to cadastral database and drawing to cadastral map of an easement	Poland and Slovakia: Proposal to cover the limits of the acquired right with a warranty in the case of fixed limits; Poland: creating a cadastral layer presenting the scope of easements
Cadastral map	Numerical/digital maps	Digital maps, approx. 50% non-numerical (without coordinates)	Slovakia: improvement of the map fund

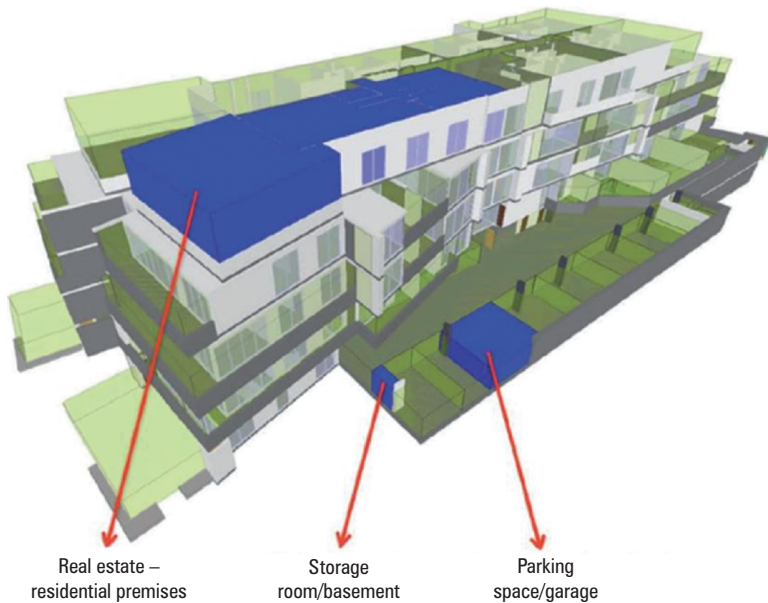
Objects subject to registration	Parcels, buildings, premises	Parcels, buildings, buildings under construction, premises, residential premises under construction, non-residential premises under construction	Slovakia: a proposal to differentiate buildings and premises occurring several times at the attribute level
Claimed rights	Ownership, perpetual usufruct, limited property rights	Ownership, pledge, lease, administration of state or municipal property, beneficiary of the pre-emptive right, beneficiary of the right of easement, Slovak Land Fund and administrator of forest land	Poland and Slovakia: the introduction of a time-limited development right to be considered in order to launch investment opportunities, including crediting spatial plots
Registration division units	Accounting unit registration precinct cadastral parcel	Registration area, cadastral parcel	Poland and Slovakia: the proposal includes the introduction of a spatial parcel object and a registration unit of a spatial object Slovakia: the need to unify the C and E registers
The applicable data exchange standard	GML	.txt/csv; .GML; .hp; .GDB; .dxf; .dgn; .stx; .vgi; .vbx; .tab	Slovakia: the need to unify the data exchange standard

Source: Authors' own study



Source: modified on the basis of Bujňáková [2021]

Fig. 6. Scheme of the hierarchical model of IFC spatial and physical units



Source: Authors' own study based on Bujňáková [2021]

Fig. 7. Proposal for real estate registration

4. Discussion of the results

The conclusions of the presented analysis correspond to other studies conducted in this field [Gajdošová 2012, Vlček 2015]. The analysis of literature on the subject [Jakubáč 2022, Slovak Business Agency 2021] also agrees with the postulated introduction of changes in the implementation of the multidimensional cadastre with the use of hierarchical databases giving the application possibilities of the proposed solutions.

5. Summary and conclusions

The similarities in the real estate cadastre in Poland and Slovakia are connected to their common history. However, the development of the register in both countries proceeded differently after the Second World War., Despite both Poland and Slovakia being members of the European Union (which aims to unify regulations), a uniform law does not exist in these countries.

In this publication, a comparative analysis was carried out with regard to research on the applicable law for implementing the multidimensional cadastre in Poland and Slovakia. The analyzed cases, supported by field interviews, indicate that the introduction of a multidimensional cadastre in both countries would be beneficial.

The conducted analyzes of the current legal status, verified by the professional experience of the authors of the publication, identify significant differences affecting the degree of complexity of the implementation of the proposed solutions. According to the assumptions of the authors, the implementation would be an evolution of the registers, which, as shown in Table 1, would be conducted differently, depending on the input data for individual countries. The Slovak cadastre is definitely more complicated in this respect. The need to register building data, digitization of the resource and standardization of the spatial data exchange scheme are problems that took over two decades to solve in Poland. As illustrated by the authors' professional experience, in Poland, despite the formal resolution of these issues, there are still cases of irregularities and problems related, for example, to the exchange of data using the GML scheme.

The implementation of the multidimensional cadastral systems in Poland and Slovakia, considering the high costs and major technical and legislative challenges, should be consistent with the generally understood social and economic interest, as the effectiveness of the cadastre functioning as a synergistic spatial database depends on it.

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