Digital Transformation of Land Administration Systems – the Next Step toward 3D Land Administration

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Key words: digital transformation, 3D Land Administration, LADM, 3D cadastre

SUMMARY

Introducing interoperability among spatial datasets and registers is one of the key drivers for optimizing public administration, starting from the simple automation of existing processes, to the overall transformation of the system, and the construction of modern user-oriented services. An additional incentive for such a transformation, in the European context, was the foreseeable need for interoperability between the national systems of registers and the European Union (EU) registers, and potentially in the future with other registers worldwide. A key prerequisite for the realization of interoperability is digitalization. Digitalization is the most important step towards the development of an effective 3D Land administration.

LADM country profiles integrate the legal and institutional context governing Rights, Restrictions and Responsibilities (RRRs) with the desired Land Administration Systems' (LASs) advancements. A significant number of countries have developed LADM-based country profiles. Experiences from these developments are in the direction of integrated Land Administration, which the LADM data standard provides, with a vision for the future and can serve as good practice for the countries.

This paper compares the digital transformation of the land administration in two vastly different case studies, in one EU country (Croatia) and in one Caribbean country (Trinidad and Tobago). A Comparison of these two land administration systems and their different tracks toward the development of a 3D land administration system that would address their differing social and economic needs within their individual resource and skill capacities was investigated in this paper.

It was found, after comparison, that the step by step process to further and develop from the existing status to a 3D cadastre that is LADM compliant is differentiated according to the needs, capacities, and resources available in each of the countries. Countries would do well to decide on their individual social and economic needs and capacities prior to embarking on a step by step process toward 3D land administration.

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1. INTRODUCTION

This paper describes and discusses the digital transformation of two different countries to compare how their processes fit their perceived priority needs and capacities. Croatia, a European country with access to developed technology and standards, has set out on the transformation of the most important parts of the Croatian land administration system. Connecting the joint information system of land registry and cadastre, Digital Geodetic Report System, Utility Cadastre System, Digital Archive System, Register of Spatial Units, National Infrastructure of Spatial Data with each other and with other public administration systems, has made a significant step forward in providing services to all entities as well as citizens, and made way for further modernization of LAS. A step forward to the 3D Land Administration in Croatia is the creation of a Building Cadastre, which is one of the more recent activities of the Croatian land administration as a new part of the real property register. Such a register should serve as a transitional register towards the establishment of a 3D cadastre.

Trinidad and Tobago, conversely, has more fundamental land tenure needs to satisfy, and fewer resources and capacities in its land administration system. The land administration system in Trinidad and Tobago is comprised of the cadastre, maintained by the Surveys and Mapping Division, the separate title registration, maintained by the Land Registry, the property valuation roll, maintained by the Commissioner of Valuations' office, and the land use datasets, maintained by the Town and Country Planning Division. These are all separate institutions with datasets that are not integrated or interoperable. The cadastre has, since 2000, been digitized but the data has not been able to be maintained current, nor to be comprehensive, because of the lack of sufficient human and financial resources. Cadastral maps for new parcel surveys and subdivisions are not incorporated into the database as readily as they should be. The cadastral maps are accessible online as scanned documents for free. The title documents at the Land Registry are digital, as the institution has recently completed a major project to digitize the title documents after the deeds had been digitized. The data in the form of scanned pdfs are accessible online for a fee. The property valuation roll is digital and reportedly contains some 400,000 residential properties but is not publicly accessible. The land use database is not digitized, nor accessible to the public. None of these datasets accommodate 3D data although the need for visualizing ownership, value and use in 3D is necessary for the relatively densely populated country where land and space are at a premium. There have been some investigations and discussions on the need for and the possibility of developing an LADM compliant system (Griffith-Charles and Edwards 2014; Griffith-Charles et al 2018). However, these would take a long time in implementation.

These two countries are on different paths toward 3D cadastre development as they have some similarities but different needs, resources, and capacities. This paper compares the steps taken with the needs, resources and capacities to determine how a country can align its processes to the 3D cadastre within its own environment.

2. DIGITAL TRANSFORMATION OF LAND ADMINISTRATION

The force of rapid developments in digital technologies and systems places imperatives upon managers of land administration systems to take advantage of the developments and to digitally transform. These transformations can assist land offices to provide more efficient services where land markets, legal environments and economic conditions are favourable, since digitally improved and modern land administration systems more easily support sustainable development goals (Kusmiarto et al 2021; Kalogianni et al., 2021). However, a country should have priority areas for development where the expenditure and direction of resources would be most effective.

According to FAO, UNECE and FIG (2022), when the spread of the COVID-19 virus became a pandemic, "many land administration organizations were already well equipped for the new normal, adapting to working at-distance, handling service spikes, responding swiftly to changing customer needs, and delivering novel data analytics services". FAO, UNECE and FIG (2022) also noted that many of these organisations operated in legal environments that supported quick adaptation of digital services to contemporary circumstances, with some of them even realising financial benefits therefrom. It was further noted that, while these organisations were able to cope with, and even benefit from, the situation, issues related to digital exclusion, data quality, standards, staff capacity, customer awareness, and partner collaboration became apparent. The authors also postulated that digital transformation of land administration systems and organisations is the *new normal*, and that this presents opportunities to improve services, create new services, and expand their client markets.

However, internationally, land administration organisations face various administrative, legal and technical challenges (Gebrihet and Pillay 2021; Kusmiarto et al. 202; Kilpin et al. 2023). The following sections describe the land administration needs of Croatia as well as Trinidad and Tobago, and how these needs have driven the process of digitising the cadastral data over time.

2.1 **Digital transformation in Croatia**

The cadastral map is the basis of Croatian land administration system. Urban planning, agriculture, construction, citizens, entrepreneurs use cadastral maps every day. The most important part of the Croatian Land Administration digital transformation is the digitisation of the analogue cadastral maps. The project to digitise the cadastral maps for the area of the City of Zagreb started in 1991 (Lipovšćak and Šurina, 1995). Other cities and municipalities developed/converted their cadastral maps in the first decade of the 21st century. The priority area for the digitisation process was therefore the more populous cities prior to continuing on the suburban and rural areas. This methodology, however, left many in the rural communities

lacking in secure tenure as the cadastral maps are still out of date and not reflective of the actual situation on the ground.

2.2 **Digital transformation in Trinidad and Tobago**

Digitisation of the various different, separated datasets has been ongoing for many years. In 1994 the reflying and photogrammetric mapping of the entire country led to the first digital topographic database, completed in 2000. It was intended that this digital topographic database would be the base layer for a digital cadastre. The existing analogue cadastral index was digitised in 2005 but was significantly mismatched to the topographic layer as well as having large voids and gaps of missing data. The purpose of this digitisation programme was to support self-sufficiency in food production so the thrust was to focus on agricultural parcels that could be allocated for this purpose. In the 1990s and 2000s, significant levels of global aid funding was devoted to developing cadastres for food self-sufficiency and then for establishing land markets as a reaction to globalisation imperatives. The programmes in Trinidad and Tobago therefore followed this trend. Figure 1 shows the original analogue cadastral index and an extract from the digitised version.

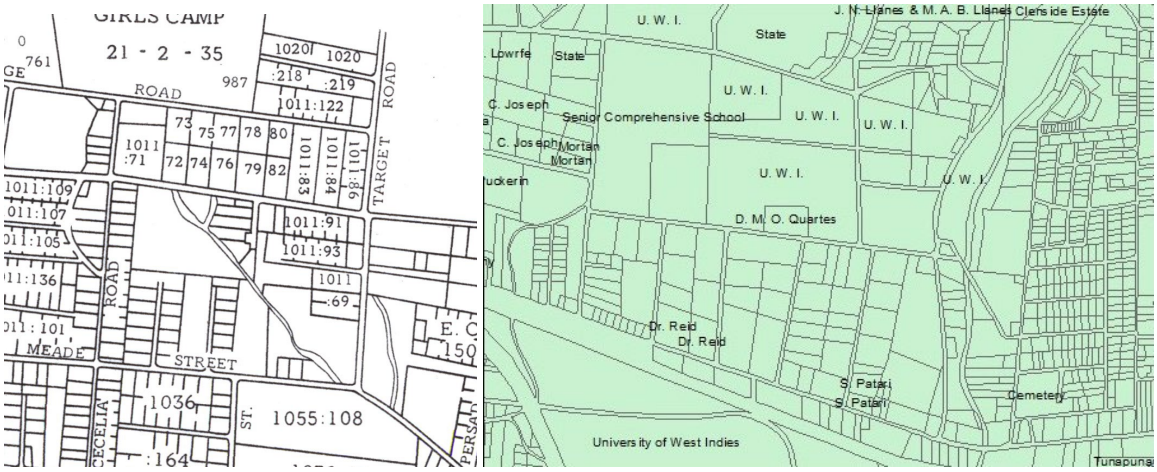

Figure 1. Paper index and early digitised index

As a result of the considerable mismatch between the datasets of the digital cadastral index and the digital topographic data, it was decided to acquire imagery at higher resolution in 2014 on which to overlay individual cadastral parcel survey data. Since cadastral surveys are not legally required to be coordinated in Trinidad and Tobago, the parcels were individually overlaid visually on the imagery. The more recent imagery has a resolution of 12.5cm so this is adequate for cadastral index purposes. The authoritative legal document is the survey plan signed by the licensed land surveyor. Figure 2 shows the imagery with the cadastral index outlines overlaid. This procedure, however, still left many gaps where surveys have not been done, long standing occupation is not legally recognised, or there is insufficient human resource to update the cadastre continuously as surveys are performed. At last count some 60,000 parcel plans remain out of the system but the larger issue is the insecure tenure that this represents.

Figure 2. Current digital cadastral index with attribute data displayed

3. 3D LAND ADMINISTRATION DATA

The limited advances in full 3D cadastres implementations throughout the world might be explained by the fact that the implementation of a 3D cadastre requires close collaboration between legal and technical experts in an empirical environment to understand the impact of each other's domain (Stoter et al. 2012). After more than two decades of using the term 3D cadastre in the world's academic and professional surveyors/cadastral circles, the current term "3D land Administration" is considered to be more apt as the multi-purpose use of the cadastral map only has been superseded by efforts to develop the whole integrated system of ownership, value, and use data . The term 'land' should be interpreted in the broad sense, also including water bodies (rivers, lakes, seas, oceans) and spaces above and below the surface, that is, air space and subsurface spaces. Land administration comprises an extensive range of systems and processes to administer: Land Tenure, Land Value, Land Use and Land Development, which are interrelated and influence each other (Kalogianni et al. 2020).

3.1 **3D Land Administration data in Croatia**

In the Republic of Croatia, there are a few sets of 3D Land Administration data available in the practice. The biggest part of Croatian 3D Land Administration are buildings and other structures. The buildings usually consist of many units of use of real properties. Currently in Croatia, buildings are registered in the land book based on the information delivered from the cadastral office. The cadastral office receives geodetic reports from licensed private surveyors usually in digital form. This information is authoritative. Ownership of a unit of use of real property (e.g. an apartment or an office space) is formed through the registration in the land book. Such unit of use may be registered if they constitute independent units of use (Vučić et al. 2013). Unit of use of real properties may include balconies, terraces, basements, and attics, under the condition that they serve exclusively a single unit of use. Land book registration of the units of use is not possible without the partition of real property procedure. LA_BAUnit consists of one or more LA_LegalSpaceBuildngUnits as one real property object with its own

RRR attached. The same procedure is commonly used in the land registry to formally consolidate land which was often publicly owned with buildings constructed on this land. The building complex first needs to be subdivided into multiple LA_LegalSpaceBuildingUnits, which can be used to form the LA_BAUnits to be registered in the Land book (adding the RRRs). Fair relationship in financing the maintenance of a building is furthermore made possible by establishing ratios of each party's ownership in the real property and each party's proportional share in the shared ownership of common parts.

The completely digitized and easily accessible Croatian land administration made a big step forward in 2020 by improving the accessibility of the service through the site www.katastar.hr with the possibility of locating oneself via smartphones and tablets. Later in 2022, that service was replaced and further improved by the joint One Stop Shop service available online (https://oss.uredjenazemlja.hr) of the State Geodetic Administration and the Ministry of Justice, also with the possibility of locating via GNSS technology embedded in smartphones and tablets (Figure 3). In a short period of time, it has become widely used by individuals and legal entities in many spheres of life, mostly in real estate-related business.

Figure 3. Building in Zagreb (Trnjanska street 63) view from cadastral parcel number 3697 cadastral municipality Trnje (Google street view)

The aforementioned service has the ability to display the Google street view service according to the given location, for all areas of the Republic of Croatia covered by the Google street view service. While Google street view only provides a 2D view of locations, the free Google Earth service provides a 3D view for urban areas (Figure 4) of the Republic of Croatia that can be used for many purposes before the official cadastral data begins to be collected and disseminated in 3D format.

Figure 4. Building in Zagreb (Trnjanska street 63) 3D view from Google Earth service

Buildings and other structures are registered in the cadastre with the following attributes: location (2D coordinates), area, intended building use, building name, and house number. A land register takes over two-dimensional data on real property from the cadastre. Real property may be further divided into common and particular parts, and registered in the land register based on the report on the particular part of the real property. Data on buildings are transcribed into land books based on the data delivered to the land register by the cadastral office. Ownership of a particular part of property (apartment or office space) is realized through registration in a land register. These particular parts may be registered if they make independent units of use. Particular parts may include balconies, terraces, basements, and attics, under the strict condition that they exclusively serve a single particular part and that they are clearly separated from other real property parts (Vučić et al. 2017).

On the State Geodetic Administration Geoportal three towns in Croatia (Sisak, Petrinja and Glina) have 3D representation of houses and buildings. The reason why only three towns (of 127 towns) have 3D graphical representation is the earthquake. The earthquake near Petrinja occurred on 29th December 2020 at 12:20 CET and had a level VIII of intensity on the Mercalli scale or a magnitude of 6.4 on the Richter scale. It was preceded by several minor earthquakes but also an earthquake with a magnitude of 5.2 on the Richter scale on the previous day. The earthquake caused casualties and huge material damage in Petrinja, but also in the nearby cities of Glina, Sisak and Zagreb. Seven people died and at least 26 others were injured, six of whom sustained serious injuries (Vučić et al. 2022). The next figure is the 3D representation of a few buildings in the City of Sisak – data captured by drone, after abovementioned earthquake (Figure 5).

Figure 5. The gymnasium building and the cadastre building in Sisak, 3D objects on the Geoportal of the State Geodetic Administration of the Republic of Croatia (source: URL 1)

In the last quarter of 2020 the State Geodetic Administration of the Republic of Croatia has started the procurement of geoinformatics services for the needs of establishing a Building Register in the pilot area in Varaždin county. These services include the development of a methodology for collecting and processing data on buildings and the development of a multipurpose data model that will consist at least of the graphic basis of the Building Register, a set of graphic data and a set of alphanumeric data. Based on the approach from this project, it is necessary to perform mass data collection and geoinformatics processing of data on all buildings in the pilot area in Varaždin county (Building Register project public procurement notice). The database should be established in order to provide integrated storage for alphanumeric and graphical (spatial) data on buildings. Processing of collected data, primarily topographical in nature, will be combined with data from other official records in order to build a more complete 3D model of buildings. During the integration of collected data with already available data from official registers, the following registers will be primarily taken in the consideration: Joint land book and Cadastre Information System (real property cadastre/land cadastre data and land book data), the Address Register and local government units' databases. Local government units' databases contain useful information about area, number of floors and real owner of real property and/or unit of use, but their databases are usually in MS Excel format or in better case in some custom made application.

Implementation of the Building Register project in the Republic of Croatia, as a new part of the real property register, is essential for the establishment of a unique register of buildings. This register will strengthen the legal security of owners and investors, contribute to the

dynamics and transparency of business processes in banks, insurance, housing policy, spatial planning and construction, enable a better overview of residence registration and building management, and ensure a simpler population census procedure (URL 2).

A significant and concrete step towards the 3D cadastre was made during the year 2022 for the needs of the Annual Program of cadastral surveys of construction areas for 2022, when aerial photography was done with unmanned aerial vehicles for all areas where a new cadastral survey was carried out. Thus, as part of that work, the geodetic contractor had to submit the following to the State Geodetic Administration: original images, elements of external orientation of shots after equalization, classified point cloud, digital relief model, digital height model, digital orthophoto maps and 3D Mesh (URL 3).

3.2 **3D Land Administration data in Trinidad and Tobago**

There is no 3D national cadastral dataset in Trinidad and Tobago, although, because of significant economic development fueled by high incomes from oil and natural gas exportation, a need for such a dataset has arisen. Many expensive high rise condominiums and apartments would be better served in conveyancing and support of property rights by a 3D cadastre that identifies the extent of the individual interests. The 3D nature of rights is represented on 2D cadastral maps by using cross sections on the maps to identify the different strata and the extents of rights. Figure 6 shows the cross sections on a cadastral plan of a residential building with many levels and many owners. These strata parcels are not included on the 2D cadastral index, are not considered to be separate parcels, and cannot be directly accessed from the online cadastral index.

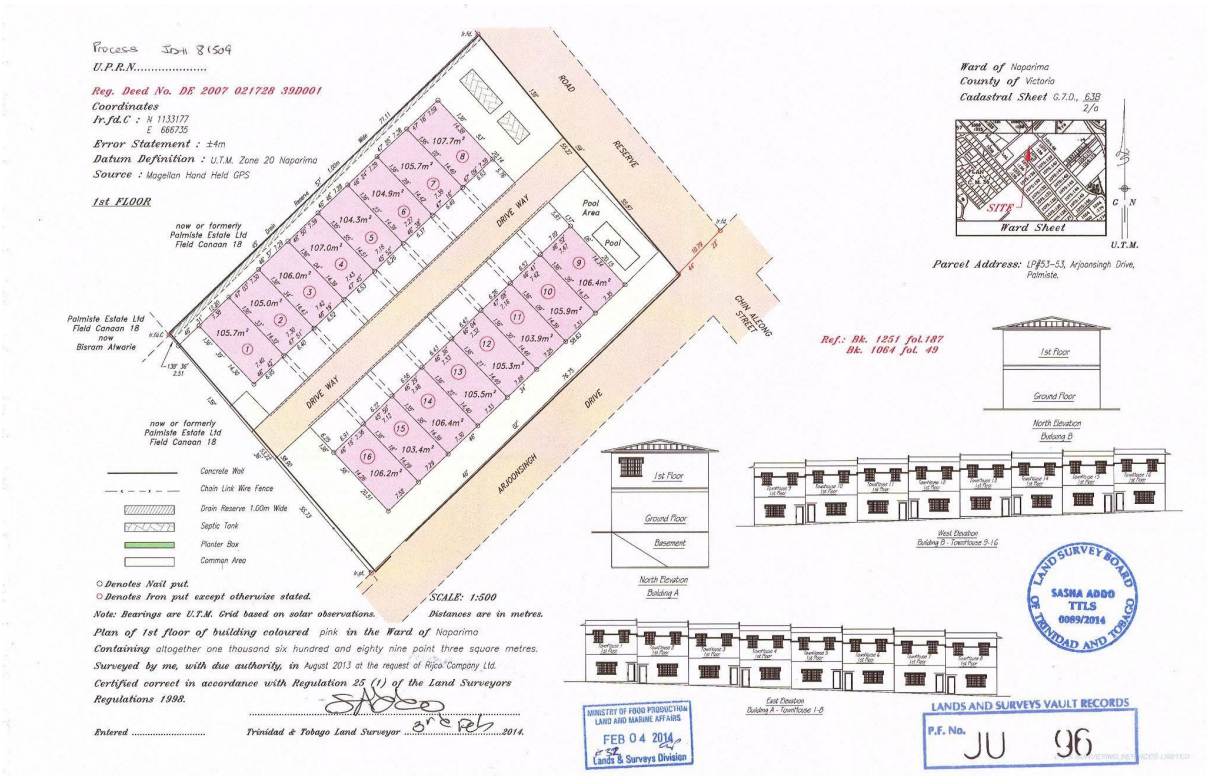

Figure 6. Cadastral maps for townhouses where cross sections indicate the 3D nature

3.3 **LADM in Croatia**

In the Republic of Croatia the implementation of the International Standard ISO 19152 – LADM is more on academic level than in the practice. There are lot of scientific paper regarding LADM and Republic of Croatia mostly produced by Croatian authors. Recent update of Croatin LADM profile produced during 2022 and introduct one new classes *HR_LegalSpaceInfrastructure* in order to support changes occured by adopting the Law on Communal Economy which recognizes different comunal objects that should be registered in cadastre. Introduction of the attribute scale to class *HR_SpatialUnit* follow the changes in geodetic profession (Figure 7). This diagram is mandatory and has a list of possible values defined by *HR_ScaleType*.

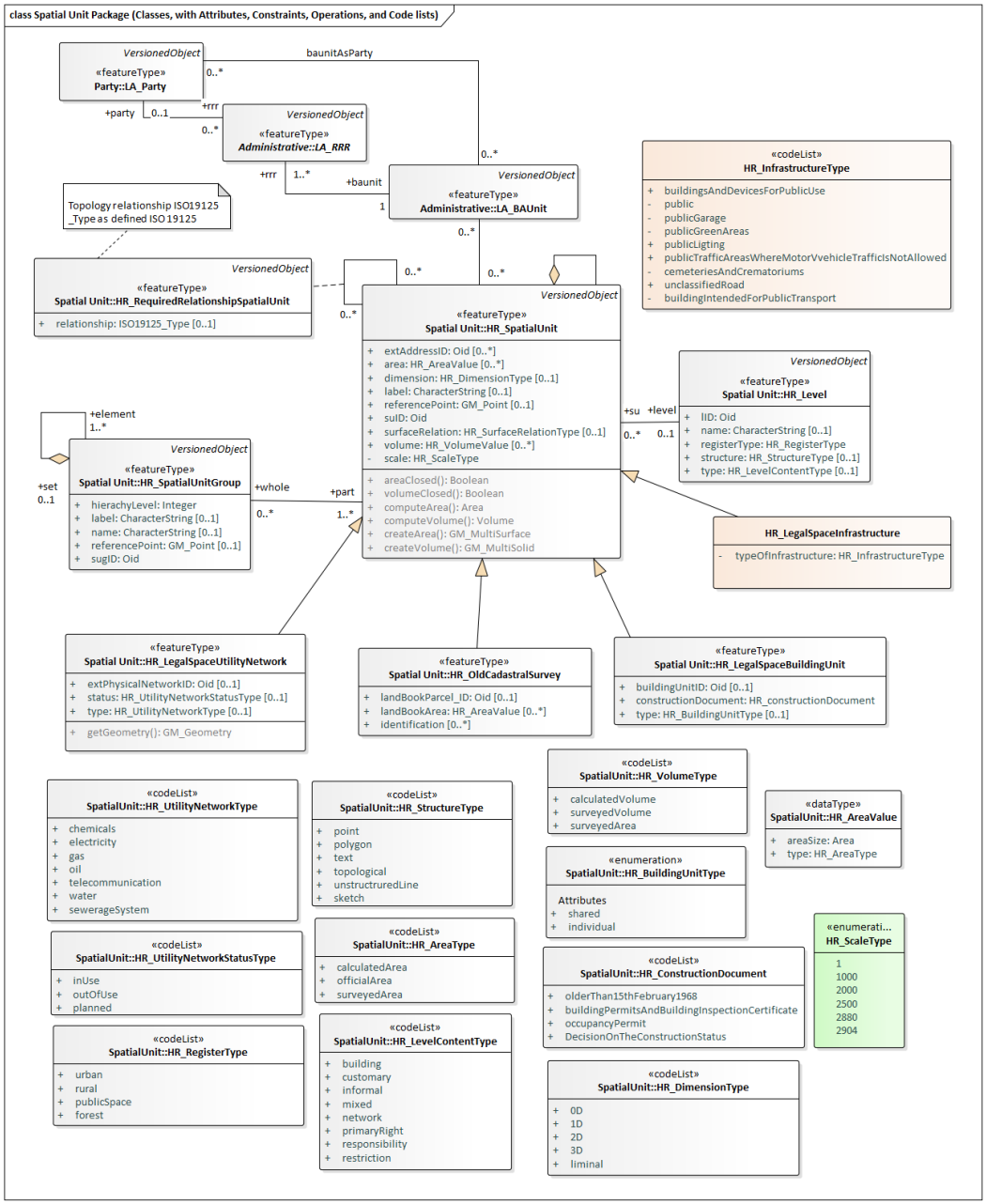

Figure 7. Revised Spatial Unit package of Croatian LADM profile (source Vučić et al. 2022)

3.4 LADM in Trinidad and Tobago

In Trinidad and Tobago the LADM is not being actively deployed and there is no official profile available. Registration of conveyancing on land does not conform to the ISO 19152 as, while the registration document is uniquely identified with an alphanumeric designation, neither the parcel being conveyed on nor the parties to the conveyance are similarly uniquely identified. Conceptual ideas about constructing a LADM profile for the informal parcels in the country have been advanced but not put into practice (Griffith-Charles 2011).

4. DISCUSSION

The importance of a 3D cadastre for Trinidad and Tobago lies primarily in its ability to support conveyancing and an active land market. This segment of the land market is in the upscale and high income residential suburbs of the country. The cost of establishing and maintaining 3D land administration for such purposes may not have the support of the public unless transaction taxes are increased to demonstrate that the state can benefit from this expenditure.

The importance of a 3D Land Administration for Croatia lies primarily in its ability to support the growing economy. The land market in the last few years in the Republic of Croatia was very active. Real estate prices increased rapidly, which coincided with the introduction of the euro as the new national currency. Also the inflation of prices on the European continent in almost every sphere of life has an impact on the real property market. Even though there were big increases in real estate prices, there were enough buyers and investors. Such a situation requires an accurate and precise description of the real property and 3D land administration is the best solution for that. The stakeholders are no longer satisfied with the representation of the building on the cadastral plan in the form of a rectangle, because this representation is completely identical to the one from 205 years ago, when the establishment of the Franciscan cadastre began on Croatian territory.

Cadastral resurvey can be one of the most efficient upgrading from 2D to 3D cadastre in Croatia. In the situation, where cadastral resurvey is selected as the best practice for improving the land administration data, we estimate that with a small extra cost it would be possible to adjust and improve this process so it would also be suitable for the systematic establishment of 3D cadastre in the most efficient way. One way to improve this is to try to use the current ongoing processes for the renewal of land administration data. In the situation, where cadastral resurvey is selected as the best practice for improving the land administration data, the estimation is that with a small extra cost it would be possible to adjust and improve this process so it would also be suitable for the systematic establishment of a 3D cadastre in the most efficient way (Vučić et al 2020).

Table 1 compares similar characteristics of Croatia with Trinidad and Tobago for purposes of comparison of needs, resources and capacities. The needs of both countries are similar as the establishment of a true 3D cadastre would satisfy the land market needs of both countries for condominiums and apartments. However, the differences in the GDPs and the per capita

GDPs indicate that there would be more difficulty for Trinidad and Tobago to channel resources into the project than it would be for Croatia. The needs of Trinidad and Tobago also extend to providing comprehensive land administration for the large percentage of informal occupants of land. This is not a need that Croatia experiences or perhaps experiences at a lower proportion of the population. Good land governance would require that Trinidad and Tobago's limited resources be apportioned equitably to securing the land tenure of all its citizens inclusive of the informal occupants.

Croatia has further advanced in the ability to register apartments and condominiums, even though it is in a separate database than the land parcels. The LADM requires one consistent definition of the land unit or LA_BAUnit. The further advancement points to a larger capacity in its land administration institutions than Trinidad and Tobago where the registration of buildings does not exist although the cadastral parcel maps show the vertical and horizontal sections to illustrate strata rights. While Croatia is ten times the area of Trinidad and Tobago but three times the population, making the task of maintaining currency in its cadastral database more difficult for the Croatians, the capacity of technology can make more effective the programmes of digitisation of the data and digitalisation of the land administration.

Table 1. Comparison of Land Administration systems and 3D products

	CROATIA	TRINIDAD & TOBAGO
Area (mainland)	56594 km²	5128 km²
Area (sea)	31067 km²	7134 km²
Number of inhabitants	3.871.833 (2021)	1,526,000 (2021)
Cadastral system	Title	Deeds and title
Land book principle (if exist)	*Superficies solo cedit*	None
Number of cadastral offices	112	2
Number of Land book offices	109	0
3D products of Land Administration	Joint Information System of Land books and Cadastre Building Cadastre – in the process of establishment Digital Elevation Model Geoportal SGA (3D for earthquake affected towns) oss.uredjenazemlja.hr (link to Google street view)	The cadastre is not 3D and buildings are not registered. No building cadastre Digital Elevation Model Geoportal for 2D cadastre overlaid on imagery None
Condominium registration	Building registration in Land Books	Legislation only in draft
Spatial planning	Closed cooperation with Ministry of Urban Planing and construction and state property Closed cooperation with Local Goverment	No planning cadastre is available
Marine cadastre	Under development	None, but oil and gas exploration block leases are mapped in the marine space
GDP Per Capita	$18,916 US (2021)	$16,000 US (2021)
GDP	$51 billion US (2021)	$24 billion US (2021)

5. CONCLUSION

This paper has explored the digital transformation of land administration systems in two distinct contexts: Croatia, a European Union country, and also Trinidad and Tobago, a Caribbean country. The comparison of these two case studies highlights the importance of aligning digital transformation efforts with a country's unique needs, resources, and capacities.

In Croatia, the focus has been on digitizing cadastral maps and embracing 3D land administration to support a growing economy and an active land market. The implementation of a Building Cadastre and other digital systems has significantly improved services and legal certainty within the land administration system. Croatia's proactive approach demonstrates how digital transformation can be leveraged effectively in a resource-rich environment.

Conversely, Trinidad and Tobago faces challenges in achieving a 3D cadastre due to limited resources and disjointed datasets. While the need for a 3D land administration system is evident, especially in high-income residential areas, the cost and public support remain barriers to its implementation. This case underscores the need for careful consideration of financial and societal factors when pursuing digital transformation initiatives.

This analysis highlights the importance of adapting digital transformation efforts to the specific needs and conditions of each country. Whether a country is resource-rich or resource-constrained, the move toward 3D land administration must be aligned with its economic, legal, and technological realities. In this way, countries can take advantage of digital transformation to support sustainable development, legal certainty and economic growth. Finally, there is no good progress towards 3D land administration without prior digitization and digital transformation of the majority of land administration data.

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BIOGRAPHICAL NOTES

Dr. Nikola Vučić graduated in geodesy from the University of Zagreb, Faculty of Geodesy. In 2015, he received a PhD from the University of Zagreb for the thesis "Support the Transition from 2D to 3D Cadastre in the Republic of Croatia". He was employed at the cadastral office in Glina from 1999 to 2004. He was the Head of the Department for Administrative and Professional Supervision at the State Geodetic Administration of the Republic of Croatia. He was the Head of Sector for Cadastral Programs and Special Registers at the State Geodetic Administration of the Republic of Croatia. He was the Head of Division for Special Registers at the State Geodetic Administration of the Republic of Croatia. He was the Head of Sector for cadastral surveys and infrastructure at the State Geodetic Administration of the Republic of Croatia. Currently he is the senior adviser - specialist in State Geodetic Administration of the Republic of Croatia. His main research interests are land administration systems, 3D cadastres and geoinformatics. He is a member of the Croatian Geodetic Society and the Croatian Chamber of Chartered Geodetic Engineers.

Dr. Charisse Griffith-Charles Cert. Ed. (UBC), MPhil. (UWI), PhD (UF), FRICS is currently Senior Lecturer in Cadastral Systems, and Land Administration in the Department of Geomatics Engineering and Land Management in the Faculty of Engineering, at the University of the West Indies, St. Augustine, where her research interests are in land registration systems, land administration, and communal tenure especially 'family land'. She is currently the Head of Department. She places importance on professional membership and is a Fellow of the Royal Institution of Chartered Surveyors (FRICS) and member of the Institute of Surveyors of Trinidad and Tobago (ISTT). She has also been President of the ISTT, President of the Commonwealth Association of Surveying and Land Economy (CASLE) Atlantic Region, and President of the Fulbright Alumni Association of Trinidad and Tobago (FAATT). Dr Griffith-Charles has served as consultant and conducted research on, inter alia, projects to revise land survey legislation in Trinidad and Tobago, assess the impact and sustainability of land titling in St. Lucia, address tenure issues in regularising informal occupants of land, and to assess the socio-economic impact of land adjudication and registration in Trinidad and Tobago, apply the STDM to the eastern Caribbean countries, and document land policy in the Caribbean. Her publications focus on land registration systems, land administration, cadastral systems, and land tenure.

Dr. Michael Sutherland holds an M.Sc.E. and Ph.D. in Geomatics Engineering from the University of New Brunswick, Canada specializing in land information management and Geographic Information Systems (GIS). He is currently a Senior Lecturer in Land Management in the Department of Geomatics Engineering and Land Management, Faculty of Engineering, The University of the West Indies, St. Augustine, Trinidad and Tobago. Michael was also Head of that department from 2017 to 2023. He previously held a post-doctoral position at the University of Ottawa, Canada where he did GIS research in relation to multi-criteria decision analysis supporting socioeconomic and environmental phenomena. He is a member of the Institute of Surveyors of Trinidad and Tobago, and is an elected member of the Royal Institution of Chartered Surveyors. In 2011 Michael was appointed as an Honorary Fellow, Sir Arthur Lewis Institute of Social and Economic Studies, University of the West Indies, St. Augustine, Trinidad and Tobago. Between 2012 and 2017 he served as Deputy Dean (Undergraduate Affairs), Faculty of Engineering, The University of the West Indies, St. Augustine, Trinidad and Tobago. In 2012 he was appointed as an adjunct professor in the Department of Geodesy and Geomatics Engineering, University of New Brunswick. Michael was also Chair (2011-2014), Commission 4 (Hydrography), International Federation of Surveyors

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