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Challenges of integrating cadastral map and urban data infrastructure in Iran

Alireza Hajiheidari *[1], Mahmoud Reza Delavar [2], Abbas Rajabifard [3]

[1] *University of Tehran, College of Engineering, School of Surveying and Geospatial Engineering, Tehran, Iran*
[2] *University of Tehran, College of Engineering, Center of Excellence in Geospatial Eng. in Disaster Management, School of Surveying and Geospatial Engineering, Tehran, Iran*
[3] *University of Melbourne, Department of Infrastructure Engineering, Center for Spatial Data Infrastructures and Land Administration, Victoria, Australia*

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Abstract

Producing rich cadastral maps of megacities is time-consuming and imposes exorbitant costs on the concerned organizations. Due to rapid urban expansion and development, keeping maps up-to-date is a significant challenge for spatially enabled government and land administration affairs. Therefore, in order to keep urban cadastral maps up-to-date and enrich their content geometrically and thematically, a number of issues should be resolved. In this research, challenges in integrating and enriching the urban and cadastral map data of different organizations in some parts of a District of the mega city of Tehran, the capital of Iran, have been investigated. Some of the important challenges are the heterogeneous methods of map production, inconsistency in the employed maps currency, existence of a variety of map scales produced in different urban organizations, lack of coordination and cooperation in map data formats, production methods, and standardization. This paper has attempted to overcome these challenges.

1. Introduction

It is believed that having rich, up-to-date and reliable urban cadastral maps is essential for urban management organizations to make reliable, informed and timely decisions. Increasing the complexity of cities, the needs and opportunities of the cities in the context of smart cities, the availability of more stakeholders than before, and also increasing urbanization in the world by 70% by 2050, increases the need for an intelligent urban cadastre (Rajabifard, 2015). This urban expansion and development increase the need for management organizations to have up-to-date and rich urban and cadastral maps. In addition, production of new maps takes much time and cost for the urban management organizations and makes maps out-of-date almost soon after their production. Therefore, urban management organizations can update their cadastral maps and spatial data infrastructure (SDI) to make the right decisions in various issues by enriching their maps through integrating their spatial and legal information. Sharing the latest spatial data facilitates urban sustainable development, have created a win-win situation for all actors in the urban management organizations such as spatial data providers, service providers, and end users (Olufunmilayo Akinyemi and Uwayezu, 2011).

Data sharing prevents duplication of data collection efforts and reduces resource waste. It may also improve data quality because it enables users to review, correct, and improve the data (Gelagay, 2017). The geospatial community needs a suitable space for sharing and accessing geospatial assets to take full advantage of their socio-economic benefits because meeting users' needs in a spatial community is beyond an organization's ability (Rajabifard et al., 2005). Some research has been conducted in different countries to examine the challenges for data integration and the creation of an SDI. Similarities and differences between cadastral maps in 8 states of Australia and New Zealand have been examined. Finally, a new cadastral framework has been considered across Australia and New Zealand (Atazadeh et al., 2021). In Ethiopia, poor organizational coordination, poor data quality and compatibility as well as institutional, legal, policy, and technological issues have been identified as significant challenges to geospatial data sharing barriers

* **Corresponding Author**

*(aliz.hajiheidari@ut.ac.ir) ORCID ID 0000-0002-6138-8657
(mdelavar@ut.ac.ir) ORCID ID 0000-0002-9654-6491
(abbas.r@unimelb.edu.au) ORCID ID 0000-0002-4256-3173

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among organizations (Gelagay, 2017). Góźdź and van Oosterom (2016) have examined the development of SDIs in Poland. This paper discusses the possibilities of developing a national information infrastructure using the Land Administration Domain Model (LADM) (Góźdź and van Oosterom, 2016). Kafashan (2020) has studied the challenges in the Iranian two-dimensional cadastral maps mainly in spatial information, descriptive information, shortages and shortcomings of urban coverage and land use. Most of the urban management organizations are incapable of meeting their spatial data needs alone. In addition, sharing geospatial data faces several mega challenges including scattering data across its respective organizations, duplication efforts in the production of spatial data, and the existence of outdated data and the problems in finding available, qualified, and sharable data (Pierre, 2016). In the data integration process, it is always necessary to preprocess and harmonize the data to become at the same format and scale as well as eliminate their errors. The data will then be combined using specific international spatial data standards and frameworks which will be evaluated at using some specifications such as ISO/TC 211 and federal geographic data committee (FGDC) standards.

2. Method

An initial review of the organizations and their data should be done in the integration process. After providing data, it should be quality controlled and pre-processed. Their format, scale, symbols, and definitions should be harmonized and then their errors should be removed and corrected. Furthermore, they eventually are integrated by global frameworks and standards. Finally, they must be evaluated. At the end, the enriched maps are obtained. The integration workflow is shown in "Fig. 1".

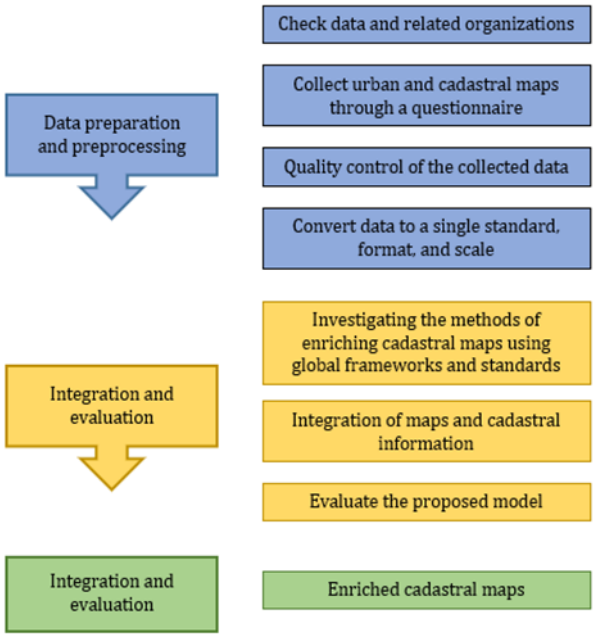

Figure 1. Cadastral and urban map integration framework.

The purpose of this study is to investigate the challenges in enriching urban and cadastral maps in District 6 of Tehran Municipality, the capital of Iran, by combining urban maps of the concerned organizations and departments of this megacity. In this research, the existing challenges in preparing and integrating data of Iran's Deed and Property Registration Organization, National Cartographic Center (NCC), and Tehran Municipality have been studied. This research has been undertaken by checking the data of these organizations and filling the questionnaires during the preparation of the data. Finally, different data from these organizations have been compared with each other to find the difficulty of map integration and suggest a way to prepare a map from different sources. The research methodology is illustrated in "Fig. 2".

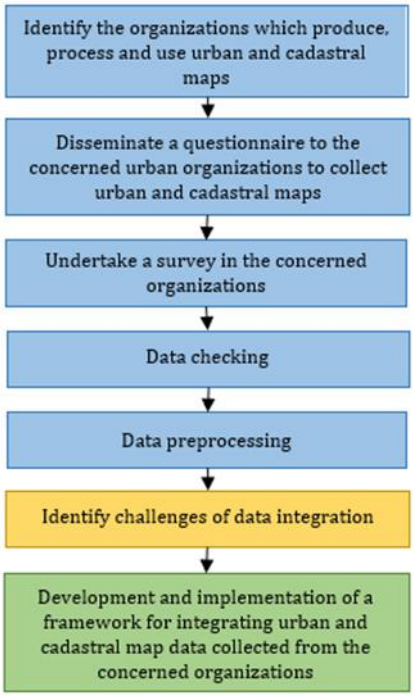

Figure 2. Research methodology.

2.1. Implementation

In this paper, the aforementioned steps have been followed according to "Fig. 2", which are elaborated in sections 2.1.1 to 2.1.5. Finally, the challenges and solutions have been addressed in the result section.

2.1.1. Identification of organizations which have cadastral and urban maps

In metropolitan areas, various organizations require cadastral and urban maps to manage the cities and provide smart services to citizens. Thus, they collect and maintain cadastral and urban maps for their organizations with appropriate accuracy for other organizations.

National Cartographic Center (NCC) of Iran is a public organization that produces national and urban topographic maps. It is worth mentioning that in 2010, NCC was appointed as the custodian of developing National Spatial Data Infrastructure (NSDI).

The Deed and Registration Organization which include Iranian Cadastral Organization, prepares judicial

cadastral maps and documents property registration records. This organization has urban cadastral maps and their registration information.

Tehran Municipality has also produced urban maps for the urban organizations in Tehran that govern and manage the city. Utility organizations are also producing some urban maps with appropriate accuracy for their intended use. These organizations usually use the municipality's maps as base maps and add their features and information to those maps.

In this study, National Cartographic Center, Cadastral Organization and Tehran Municipality have been considered as the main organizations under study, and their maps have been compared. Tehran District 6 has been considered as the study area as shown in "Fig. 3".

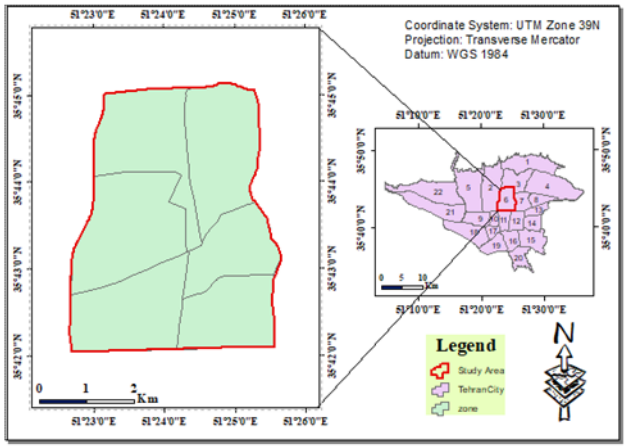

Figure 3. Study area

2.1.2. Development of the questionnaire

To examine the differences and processes followed by the organizations for urban cadastral and spatial data infrastructure production and enrichment, a questionnaire has been prepared with the following questions as mentioned in "Table 1".

Table 1. Questions considered for identifying the available data in the concerned organizations

Number	Questions
1	How to store and share cadastral and urban map data in your organization?
2	What does your organization's metadata include?
3	What is your organization's standard for urban and cadastral map data preparation?
4	What information has been added to the urban and cadastral maps for the spatial and thematic data enrichment in your organizations?
5	What is your organization's data sharing limitation?

2.1.3. Survey of experts in organizations

Some questionnaires in the concerned organizations have been completed with the assistance of some senior experts and examined in order to obtain and check the employed data. The employed process has been mentioned in the following sections. Because of poor metadata for each organization's data and a number of different overlapped data in organizations, this survey is essential to decide which data are more matches to the urban cadastral and spatial data enrichment process.

2.1.4. Data cheking

National Cartographic Center has produced maps at a scale of 1:2000 in 2002 from a number of urban areas using photogrammetric technique. Various information is available at different map layers.

One of the basic maps of the Cadastre organization is the 1:2000 maps produced by NCC in 2002 to which the registration information has been added. In addition, new properties for which a deed is required to be issued will be re-registered and their maps updated. In order to prepare maps in the Cadastre organization, judicial permits are required to access the registration information. In order to access the geometric data, the desired area must be specified according to the registration areas, and a request must be sent to the Cadastre organization. The registration information is stored in a system designed for this organization. This information is based on the quadruple and boundaries of the property, and there is also information about the whole property that requires registration knowledge and designed software.

Tehran Municipality has also urban maps at different scales that have been produced in different years. Their most recent maps are at the scale of 1:1000 produced in 2014 using photogrammetric and ground surveying methods. In case of modification or change of a property, this item is updated. These maps can be produced according to the municipality's zoning on the intended site. Updated information is added to the maps in the form of different layers and databases.

2.1.5. Data preprocessing

At this stage, the geometric information of the organizations is pre-processed for urban and cadastral map integration and enrichment. Data preprocessing varies according to the map production standards, data format, and scales which suffer from the challenges outlined in "Section 3".

3. Results

The available information about the data is given in "Table 2".

Following standards such as International Organization for Standardization (ISO) and Open Geospatial Consortium (OGC) leads to standardization of definitions and facilitates for the urban and cadastral map integration. The data of Tehran municipality and National Cartographic Center have the same standard, and the basic maps of the Cadastre organization follow these standards. However, the standard for updating the cadastral maps has not been indicated to the users. Tehran municipality still uses Organization for the Advancement of Structured Information Standards (OASIS) open-source data standards. For this research, ISO and OGC standards are considered as final data standards. Different data formats, make it difficult to display and integrate the data with each other.

Furthermore, in the format such as DWG (AutoCAD Drawing Format) used in the National Cartographic Center and the Cadastre Organization, descriptive information cannot be added to features and data must be layered and symbolized to distinguish from each other. However, GIS formats such as shapefile (shp), which is used in Tehran Municipality, support descriptive information for each feature to separate the employed data and the symbology. So, all of the data is converted to shapefile and added attributes based on different layers and labels in AutoCAD. Different years and methods of map data production cause differences in the contents of the maps and their accuracies. Using ground-based methods reasonably enhances the map accuracy. It is necessary for Tehran Municipality and the Cadastre Organization to update their maps due to the new constructions or transfer of property rights. Examining the topology of features identifies inconsistencies in data and makes data more consistent. In addition, modifying the data, makes it possible to implement spatial and thematic analysis on the updated cadastral and urban map data.

Table 2. The employed urban and cadastral maps

Organization	NCC	Cadastre organiza-tion	Tehran municipality
Standard	OGC, ISO	Unknown	OGC, ISO, OASIS Open
Scale	1:2000	1:2000	1:1000
Data format	DWG	DWG	SHP
Production year	2002	Since 2002	2014
Production method	Photogram-metric and ground surveying methods	Updating the base map	Photogram-metric and ground surveying methods
Terminated/ Updated?	Terminated	Updated	Updated
Topology correction	No	Yes	Yes

4. Discussion

These differences pose challenges such as the need to harmonize the implemented standards, formats, and scales, as well as validating data topology in the data preprocessing stage. Following a single standard and preparing data in the same format and scale reduces the challenges of data integration and having complete metadata accelerates this process.

5. Conclusion

Unprecedented urbanization necessitates the production, revision and enrichment of urban and cadastral maps for informed urban management. The integration of existing urban and cadastral maps will save cost and time to develop a complete urban data infrastructure. In this study, the existing challenges in integrating the urban and cadastral map of District 6 of Tehran Municipality of the three organizations including Cadastral Organization, NCC and Tehran Municipality, were investigated. The most important challenges include implementation of inconsistent mapping methods, map scales, data formats, production years, data preparation, sharing standard, and incomplete metadata employed by the concerned organizations. Having a unified map production standard and specifications and production of the harmonized and integrated spatial, semantic and thematic urban and cadastral map data overcome these problems in the urban map data enrichment phase. Furthermore, having complete metadata accelerates the urban and cadastral map preparation and integration. In this research, ISO and OGC standards have been used and tackled. All of the data have been converted to the shapefile format, topologies corrected, and maps generalized to a 1:2000 scale to prepare them for their integration in order to produce an enriched urban and cadastral map.

At the future steps of this research, the data will be examined from semantic differences, descriptive information, and features' spatial boundaries of the urban and cadastral maps collected from organizations. Finally, the preprocessed data will be combined by smart spatial fusion methods such as Rough Set Theory (RST), Dempster-Shafer Theory (DST) and Granular Computing (GrC) enabling a reliable assessment of the enrichment and fusion process.

References

Atazadeh, B., Olfat, H., & Rajabifard, A. (2021). 3D Cadastre in Australian and New Zealand Jurisdictions: Similarities and Differences. 7th International FIG 3D Cadastre Workshop. New York, 153-184.

Gelagay, H. (2017). Geospatial Data Sharing Barriers across Organisations and the Possible Solution for Ethiopia. International Jounral of Spatial Data Infrastructure Research, (12), 62–84. https://doi.org/10.2902/1725-0463.2017.12.art4

Góźdź, K. J., & van Oosterom, P. J. M. (2016). Developing the information infrastructure based on LADM – the case of Poland. Survey Review, 48(348), 168–180. https://doi.org/10.1179/1752270615Y.0000000018

Kafashan, M. R. (2020) ' Creating a Three-Dimensional Cadastral System for Spatial Reflection of the Third Dimension in Legal Laws: Case Study of Real Estate Parking Documentation, Master's thesis (In Persian with English abstract), Islamic Azad University, Science and Research Branch, Tehran, Iran.

Olufunmilayo Akinyemi, F., & Uwayezu, E. (2011). An Assessment of the Current State of Spatial Data Sharing in Rwanda. International Journal of Spatial Data Infrastructures Research, (6), 365–387. https://doi.org/10.2902/1725-0463.2011.06.art16

Pierre, E. H. J. (2016). Analysis of data sharing environment and major challenges currently being faced in data sharing in Rwanda.

Rajabifard, A. (2015). Smart future cities—The role of 3D land & property & cadastre information. The World Cadastre Summit, Congress & Exhibition, Turkey.

Rajabifard, A., Binns, A., & Williamson, I. (2005). Creating an enabling platform for the delivery of spatial information. The national biennial Conference of the Spatial Sciences Institute, Melbourne, 11.