Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (A case study of Hanoi city, Vietnam)

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Abstract: Open source technology has been extensively used in the land administration sector in developing countries including Vietnam. Many sectors have developed applications based on open source platforms, but the state management, especially in the land registration activities is very limited. At present, land users must directly come to the land registration office or commune people's committee to carry out the land registration. This activity causes overloading to the handing unit and complicates administrative procedures. But if the work is done online, the land user will be able to carry out land registration procedures at home. In this article, based on the open source application and cadastral database, we designed a cadastral information system to support land information searching, online land registration and land information transparency. With this system, land users can look up information on land parcels, carry out procedures for land registration for the first time, and receive a notice of land finance. The pilot system was conducted in Quoc Oai town, Quoc Oai district, Hanoi city and achieved positive results in meeting the requirments of a cadastral information system. We could therefore suggest that this system could be extended to other administrative units of Hanoi city.

Key words: open source, cadastral database, land registration, Quoc Oai.

1. INTRODUCTION

Effective land information management is crucial to achieving the land management sustainability (Arif, 2017). It is required to establish a cadastral database to operate the land information system. The cadastral database will be used for various purposes such as land use tax, transfer tax, leases for urban construction such as water supply and drainage, telecommunications, electricity,...(Mark de Berg, 2000). The cadastral database also contributes to the work of land registration that aims at filling the cadastral file system to protect the legitimate rights and interests of land users. Land management with the use of information and communication technology (ICT) is a crucial element for improving housing management and urban development (Arif, 2017) for sustainable development. Currently, there is a large number of land information projects that significantly contribute to the collection, sharing, and collection of online cadastral data management (Zeynel Abidin Polat, 2017). However, the current cadastral database linking to the e-government in Vietnam is still limited.

Many developed countries have already established multidisciplinary land administration systems. For instance, in the Netherlands, the Kadaster information system has been built for the distribution of geographic information, registration of cadastral data, national registration of personal data, real estate. Also, Kadaster has constructed a spatial data infrastructure (SDI)

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

that connects the European land information service system to other sectors (CHJLemmen, 2001; Rik Ebbeling, 2011). In Korea, the KLIS land information system was set up to accurately manage the land information database (Lee Seong Hwa, 2014). KLIS has developed a system of land administrative support functions, land transaction licensing functions, issuance of land price management certificates, cadastral file management systems, provincial and central administrative systems. The task of receiving online processing of public administrative services creates statistics on the use of subordinates (Lee Seong Hwa, 2014). These studies have shown the need to improve the cadastral database associated with e-government for land registration and the completion of cadastral files. The online systems significantly contribute to the simplification of administrative procedures in the land sector.

At present, open source technology is booming, with free or low-cost advantages (Barton, 2002). Vietnam also has a policy for implementing an open source platform on the national scale. Since 2004, the Prime Minister has approved Decision 235/2004/QD-TTg on the overall project of application and development of open source software in Vietnam in the period of 2004-2008 (Prime Minister, 2008), which helps setting the foundation for open source software development. However, the use of open source software in state agencies is limited, especially in the field of land management. In reality, 5.86% of overall systems were built based on open source platform (Hanoi People's Committee, 2014). Therefore, using open source technology in the building cadastral database for land registration and cadastral file management is very necessary.

2. OPEN SOURCE PLATFORM IN THE CONSTRUCTION OF CADASTRAL INFORMATION SYSTEM

Open source software refers to products, in which source codes are publicly available, and users have free access to them. Moreover, open source software allows viewing, modifying, and upgrading of source code based on certain principles. Currently, open source software includes software running on the server and workstation.

Open source software on the server: the main functions are the spatial database management, attribute, and analysis, information processing. On the other hands, workstation software is mainly used for accessing information, analyzing data on personal computers.

Database management system

Currently, database management systems are quite diverse, but the most popular database management systems are PostgreSQL and MySQL. My SQL is widely used in many systems such as Wikipedia, Google,...This database management system is capable of spatial data management thanks to the Spatial Extensions extension which enables the archiving of the analysis of Geographic Functions (My SQL, 2018). PostgreSQL is the database management system used primarily in spatial data-related fields. PostgreSQL has an extension for spatial data management, PostGIS, compared to the spatial extension of MySQL. PostGIS provides functions to analyze and process spatial data in a powerful way (Rik Ebbeling, 2011). In addition, PostgreSQL and PostGIS are supported by proprietary software, including ArcGIS and become *de jure* standard software for spatial data management.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

Map server

Currently, there are several map server platforms such as GeoServer, MapServer, and Degree. The map server connects to database management systems such as PostgreSQL / PostGIS, ArcSDE,... and is supported by WebGIS standards such as Web Map Service, Web Feature Service, Transactional WFS.

Map Server is a favorite open source project, which aims to display dynamic spatial maps on the Internet (Stefan, 2012). MapServer includes a number of critical features, including support for presenting hundreds of vector data formats, raster and database formats, and support for a variety of operating systems (Windows, Linux,...), supports programming languages such as (PHP, Python,...) to provide advanced utilities (Daniel, 2009), good quality output, and is used by many open source software (MapServer team, 2018).
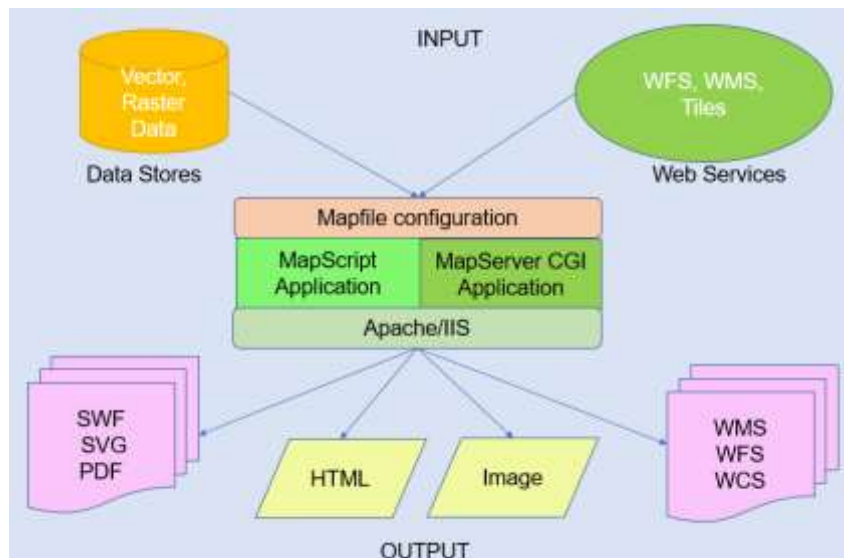

Fig. 1. 1. The basic structure of MapServer

The software that runs on the workstation helps users display and process information. The software has more and more diverse functions such as QGIS (Quantum GIS), uDIG (User-friendly Desktop Internet GIS), gvGIS and so on.

Currently, in Vietnam, land registration procedures are implemented at the Land Registration Office or Branch Office of land registration at the district level. Administrative units of communes, wards and townships are the basic units for the establishment of the cadastral database. However, online services in land registration and certification are limited, therefore, the establishment of the cadastral information system for this purpose will simplify the administrative procedures and reduce the pressure on governmental agencies

In developing countries, the cost of using commercial software is a barrier to the construction of cadastral information systems (Ho Ngoc Anh Tuan, 2015). Therefore, the use of open source technology for database and information systems becomes an alternative to proprietary software at a lower cost and more convenient (Dimitrios, 2013). In fact, in many provinces in Vietnam, VILIS (Vietnam Land Information System) has been deployed for the establishment of a database and the operation of the land information system, but the land registration is still

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Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

very limited. In this paper, the study uses the PostgreSQL database management system, PostGIS combined with ViLIS to build the cadastral information system of Quoc Oai town, Quoc Oai District, Hanoi.

3. PROTOTYPE CADASTRAL INFORMATION SYSTEM FOR LAND REGISTRATION AND COMPLETING THE CADASTRAL FILE SYSTEM USING OPEN SOURCE SOFTWARE

3.1. Study area

Quoc Oai Town is located in the center of Quoc Oai district, Hanoi. It shares the east borders with Yen Son village, adjacent to Day river, and Van Con village of Hoai Duc district. It is situated west of Ngoc My village, Phung Xa village of Thach That district. In the southwest, it borders on Thach Than village. In the North, it borders on the Phung Xa village of Thach That District and it borders Dong Quan village to the south.

Fig. 1. 2. Location of QuocOai town in QuocOai district, Hanoi

3.2. Data and methods
3.2.1. Data

Types of data collected for research purposes include:

- 29 cadastral maps of 1/500 residential land and 31 cadastral maps with a scale of 1/1000 agricultural land measured in 2010 of Quoc Oai town.

- Book township land inventory of Quoc Oai.

- Register of certificated land of Quoc Oai town.

- Cadastral book of Quoc Oai town.

3.2.2. Methods

- GIS method: In order to build a database for operating cadastral information systems, GIS is used to process spatial analysis, standardize information layers.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

-Methods of analysis and design of WebGIS system: This method is used to analyze and describe layers of information on WebGIS system, using programming language to design tools for the first time registration of land, receiving information on financial obligations on land.

-Methods of evaluation and testing: To verify the research results, the system assessment was conducted with the participation of 4 officials and 20 people in the study area based on different criteria.

3.3. Construction of cadastral database in Quoc Oai town

Cadastral database is a collection of structured information about cadastral attribute and spatial data. These include data for making and adjusting cadastral maps, land registration, granting land use right certificates, ownership of houses and other assets attached to land and land administration records (Ministry of Natural Resources and Environment of Vietnam, 2017). In the process of building a cadastral database, cadastral maps are preferred for the building of spatial data and a certificate store is used primarily for the building of cadastral data.

- Build the spatial cadastral database.

Digital cadastral maps were collected in Quoc Oai Town on MicroStation software, but there are still bugs such as objects not yet at the specified level, topology relationships not guaranteed (interruptions blank, overlapping), some maps are not frequently updated .

With the MicroStation and Famis tools, subjects are taken to the levels specified in Circular 25/2014 of the Ministry of Natural Resources and Environment on a cadastral map. The maps are dynamically updated based on the book of land changes. To put into operation, map fragments are exported as * Shapefiles and added to Vilis 2.0.

Table 1. Structure of cadastral database

Column name	Full column names	Type	Column name	Full column names	Type
THUAID	ID parcel	Double	DTSD	Area of use	Short
XAID	ID village	Long			
SHBANDO	Map number	Short	TENCHU	Owner name	Text
SHTHUA	Parcel number	Short	DIACHI	Address	Text
DIENTICH	Area	Double	MDSD2003	Purpose of use 2003	Short
DIENTICHPL	Legal area	Double	KH2003	Symbol 2003	Text
MALOAIDAT	Land type code	Short	MSCOLOR	ID color	Short
KHLOAIDAT	Symbol of type land	Text	SHTHUATAM	ID temporary parcel	Text

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

DIADANH	Place name	Text		DTTHOCU	Area of residential	Text

According to Circular No. 75/2015 of MONRE, cadastral data includes information on land plots, use purposes and users (Ministry of Natural Resources and Environment of Vietnam, 2015). Therefore, we proceed to build the cadastral data structure to provide information on land plots such as parcel code (THUAID), parcel number (SHTHUA), area (DIENTICH),... information about purpose used as: land type code (MALOAIDAT), Symbol of type land (KHLOAIDAT),... and user information such as full-name (TENCHU), address (DIACHI),...
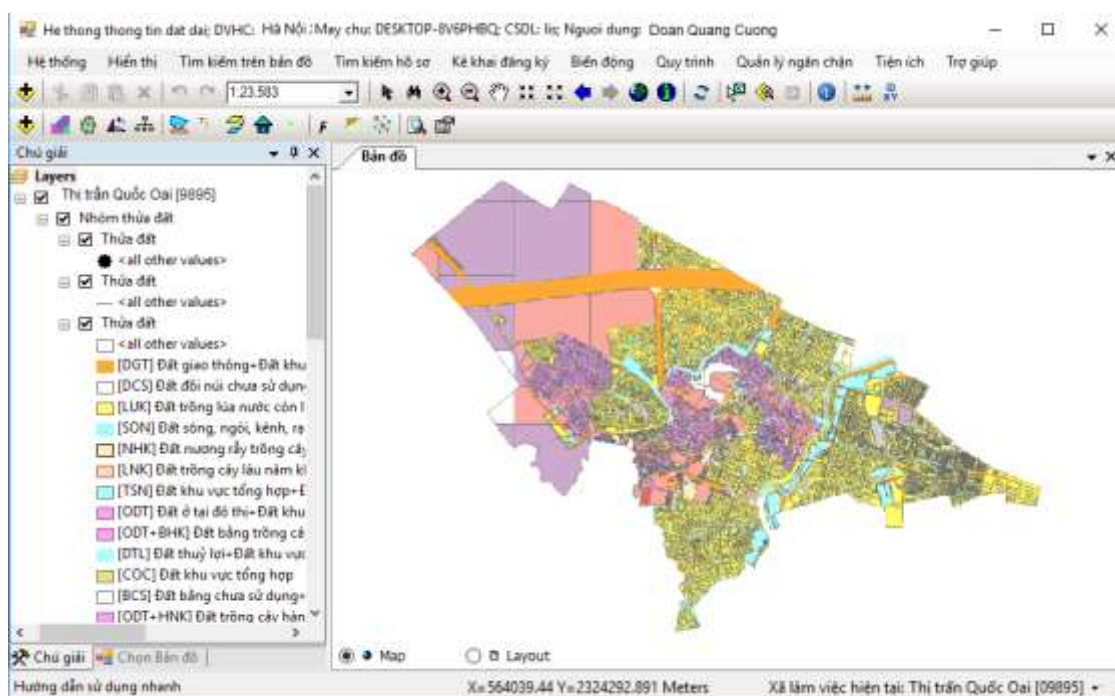

Fig. 1. 3. The cadastral database in VILIS software

- Build a cadastral database.

Cadastral attributes include data on land parcels and land users. Accurate cadastral data contribute to quick land registration procedures and secure cadastral records. Land registration has also been shown to increase activity in the land market (Klaus Deininger, 2009), as this is a legal basis for protecting the rights and interests of land users. By the modules on ViLIS, the study conducts the first registration and change registration based on the cadastral book, change register, land register and publishes the electronic cadastre, sets up automatic forms.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
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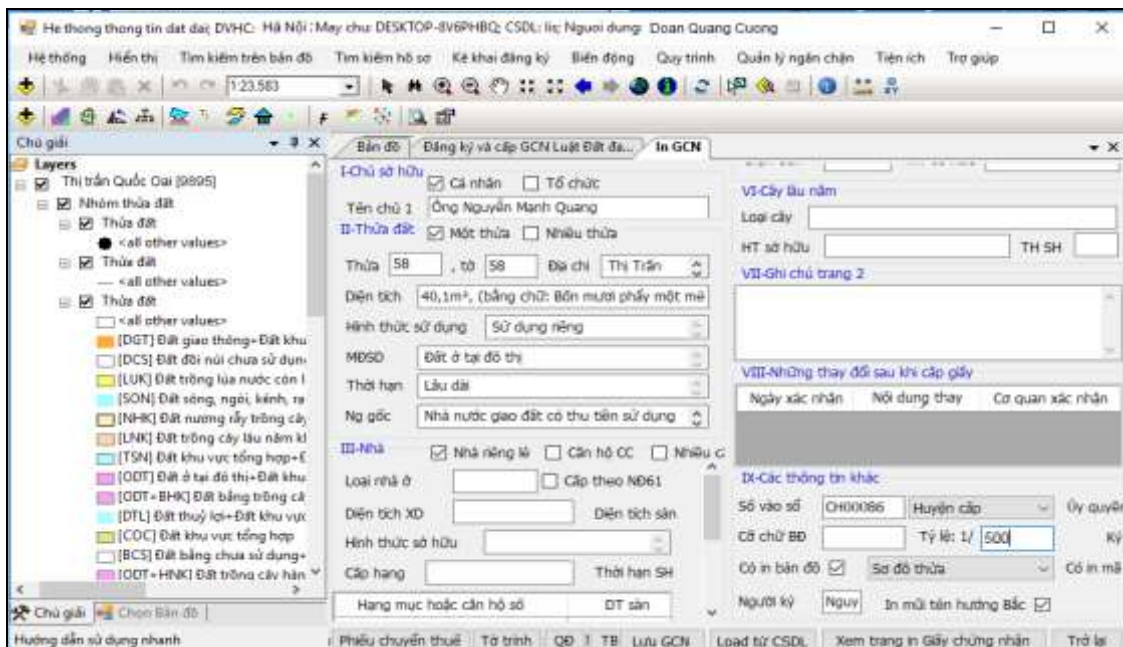Hanoi, Vietnam, April 22–26, 2019

Fig. 1. 4.Registration for the issuance of land use right certificate

3.4. Build the cadastral information system to support online land registration

<u>a. System structure</u>

Different users have different access rights. We identify the users of the system including: guests, who have registered to use the system, the system administrator. The user group consists of unregistered people and only has accidental access to the system. Guests can view common information about land use status, land use planning, but cannot use the advanced function of the system. To use the advanced functions, guests must register as members on the system. Users who register as members are citizens, who send data about personal information and perform login authentication procedures to ensure the security of the system. Land users can access all information about their land plots but can only see some information about land plots of other people. When the user queries information from the database if the query only requires attribute data, the system processes and returns the results as tables. If the query command requests map data, the query will be processed through MapServer and retrieved from the database management system and returned to the HTTP server. The results are displayed to the user through the HTML protocol.
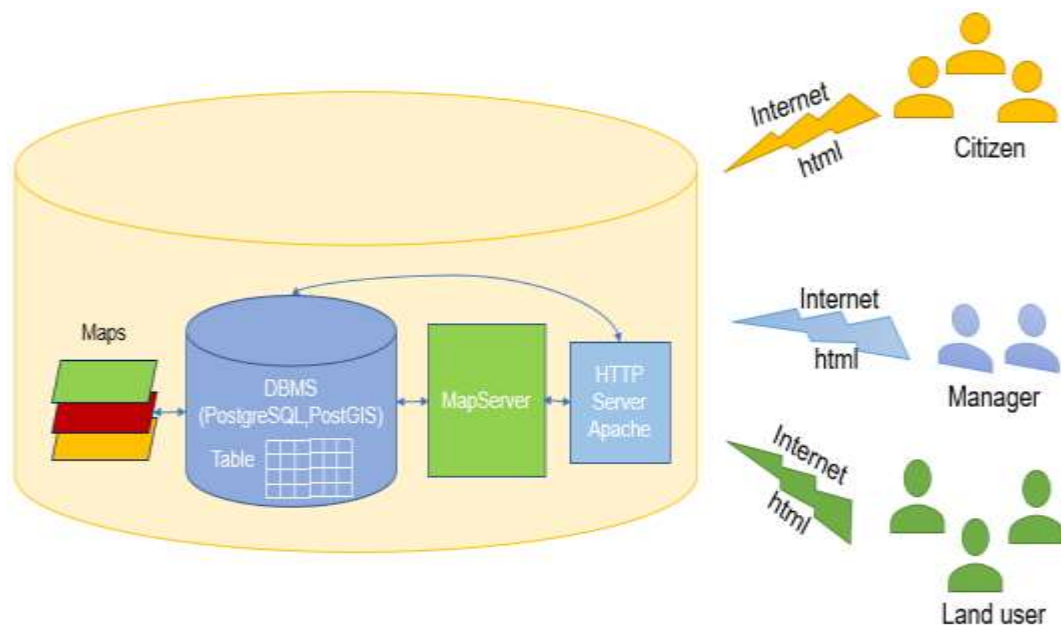
Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

Fig. 1. 5. Information System Structure

b. System data

Database is stored in PostgreSQL/PostGIS and this database management system is connected to Vilis. Apart from cadastral information, land use planning information is used as a legal basis for land registration and certification. With any information system, the security of user information is essential, so the system login password is encrypted as a string of characters. Besides, the data from the land registration application of the user are sent to the system,...

Table 2. The data structure of the cadastral information system

Datasheet	Description	Attributes
Thua_dat	Data on cadastral	Parcel ID, map number, the purpose of use, address, area and user information, etc.
Quy_hoach	Data on land use planning	Planning ID, planning purpose, planning area, project name.
Tai_khoan	User data	Username, password, access code.
Phan_quyen	Data decentralized users	User name, decentralization code
Dia_danh	Data on places and addresses	Name of the village, the administrative center, schools, healthcare.
Dang_ky	Data from the land registration application	Registration number, map number, parcel number, area, land user, ID card, year of birth, address, certificate number, date of issue.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

Datasheet	Description	Attributes
Xac_nhan_DK	Registration confirmation data	Updates from user registration

c. Operation and function of the system

To use the system, users need to have account access to the system through the "account registration" utility. After completing the account registration, the user can use the basic utility such as:

+ Manage map data display (zoom in / out, turn data layers off).

+ Search the cadastral information (look up by attribute, look up by space).

+ View cadastral map data, planning map data.
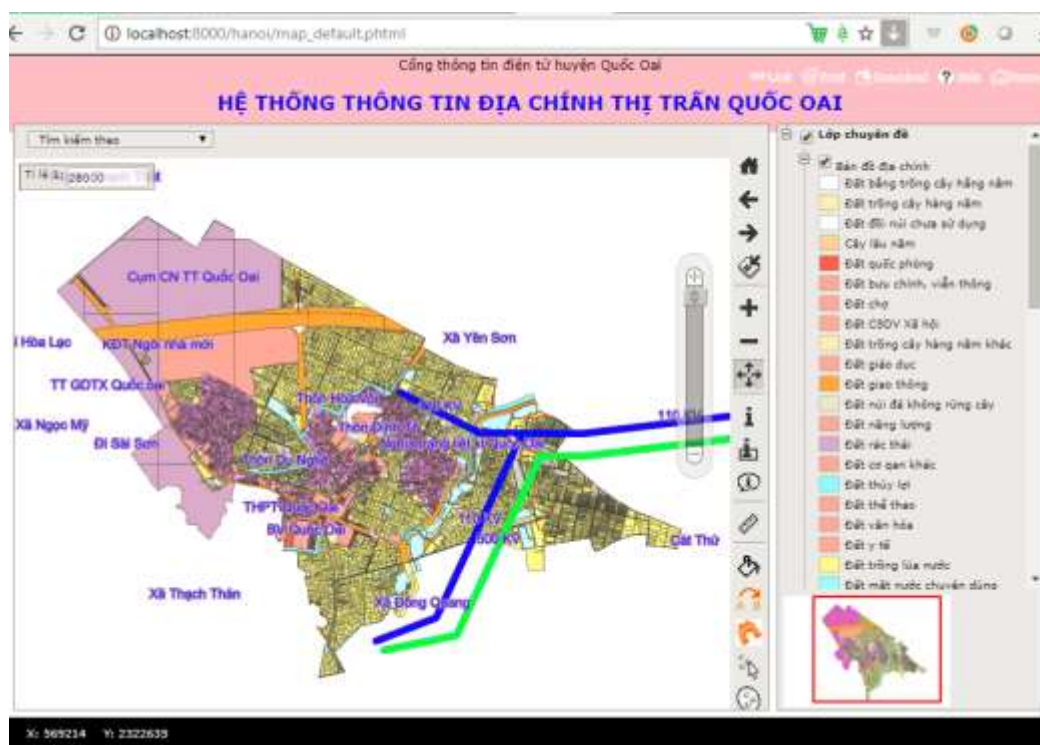
+ Measure the distance on the map

Fig. 1. 6. The interface of the cadastral information system of Quoc Oai town

Figure. 1.7 is an example when users access the cadastral map information. Owners of land parcels may view all information on their land plots, but for other land parcels, only specific information can be viewed such as the map number, plot number, area, owner, address, legal status (have a certificate of land use right / no land use right certificate) and no right to access information on certificate numbers, personal information of land users. In addition to information on land parcels, planning information provided by the system contributes to land market transparency. This is also a legal basis for land registration, granting land use right certificates.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

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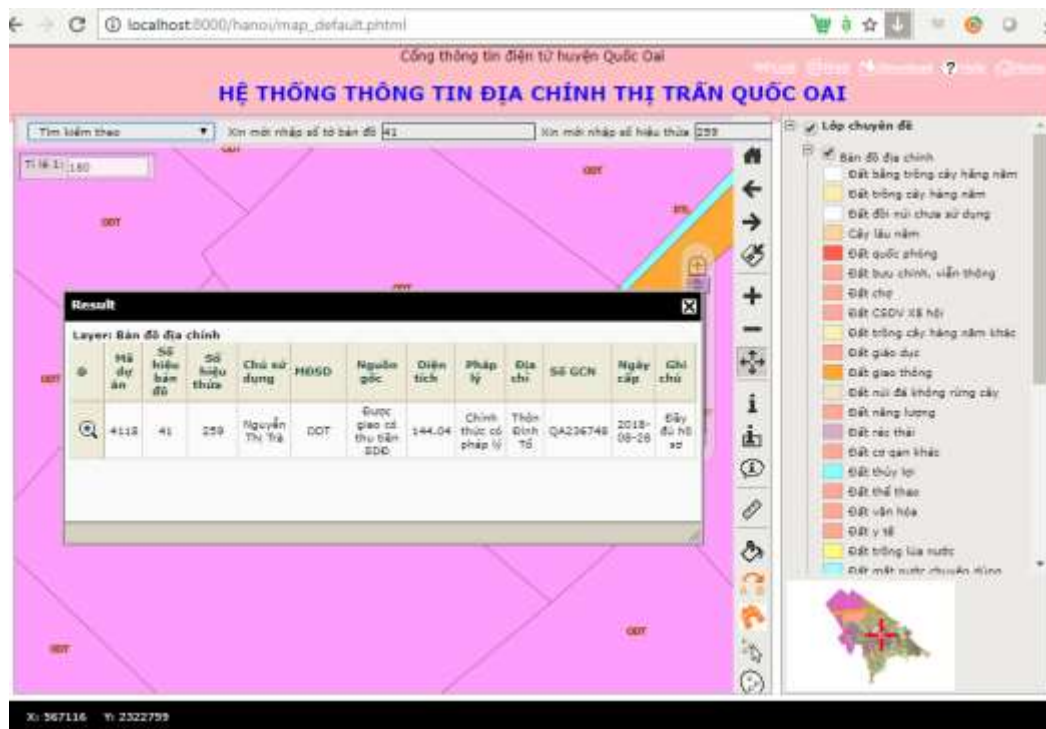Hanoi, Vietnam, April 22–26, 2019

Fig. 1. 7. Search parcel information

In addition to the necessary facilities, the system provides the first land registration function to reduce the number of applicants directly at the registration office, the People's Committee of the commune. In addition to the form filler information, the land user must download the file, including the application form, land use rights documents, financial obligations documents, restricted use rights documents adjacent land plots (if any).

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
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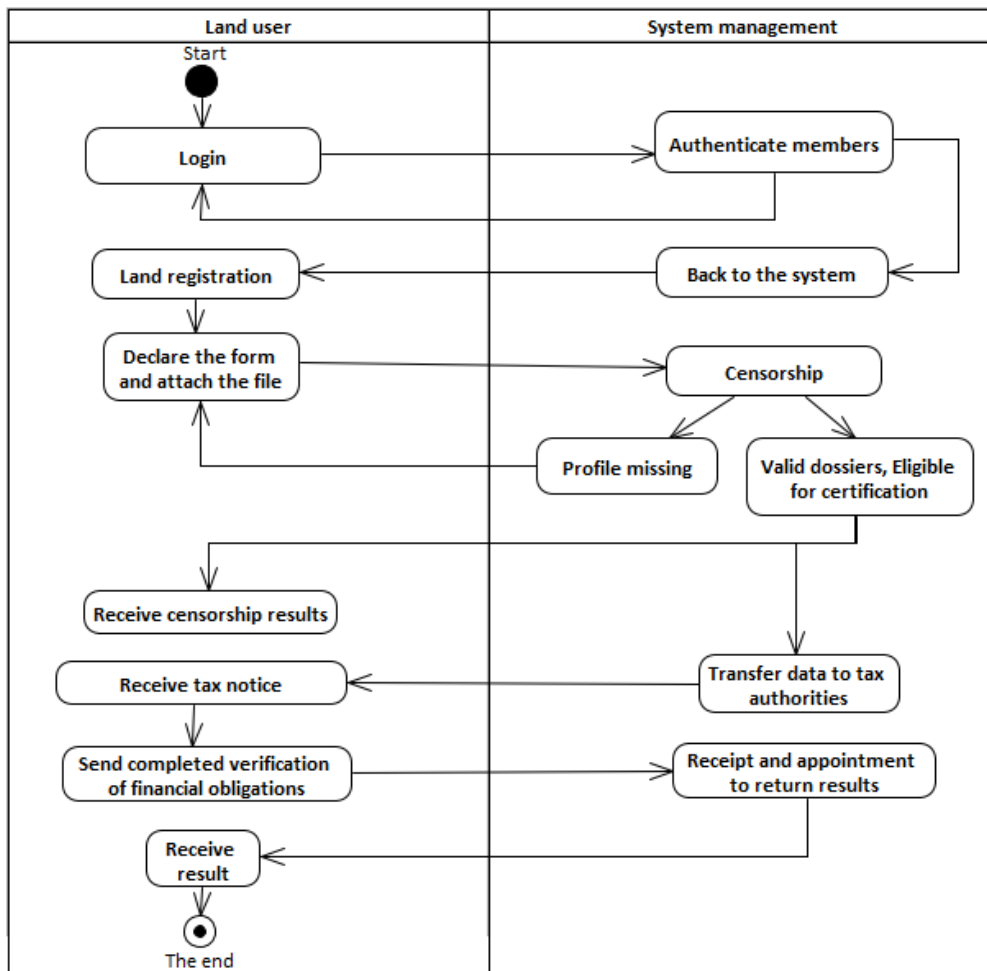Hanoi, Vietnam, April 22–26, 2019

Fig. 1. 8. The first registration operation of the system

After receiving the registration from the user, the system administrator will coordinate with the Land Registration Office and the People's Committee of the commune where the land is located to verify the information in the file, if the dossier is incomplete, the system will send notification to the user within three days. The cadastral information system is not only a data management tool, but it also ensures inter-sectoral reform such as taxation, customs, etc. Therefore, the system also provides information about land taxes, fees for the implementation of land registration.
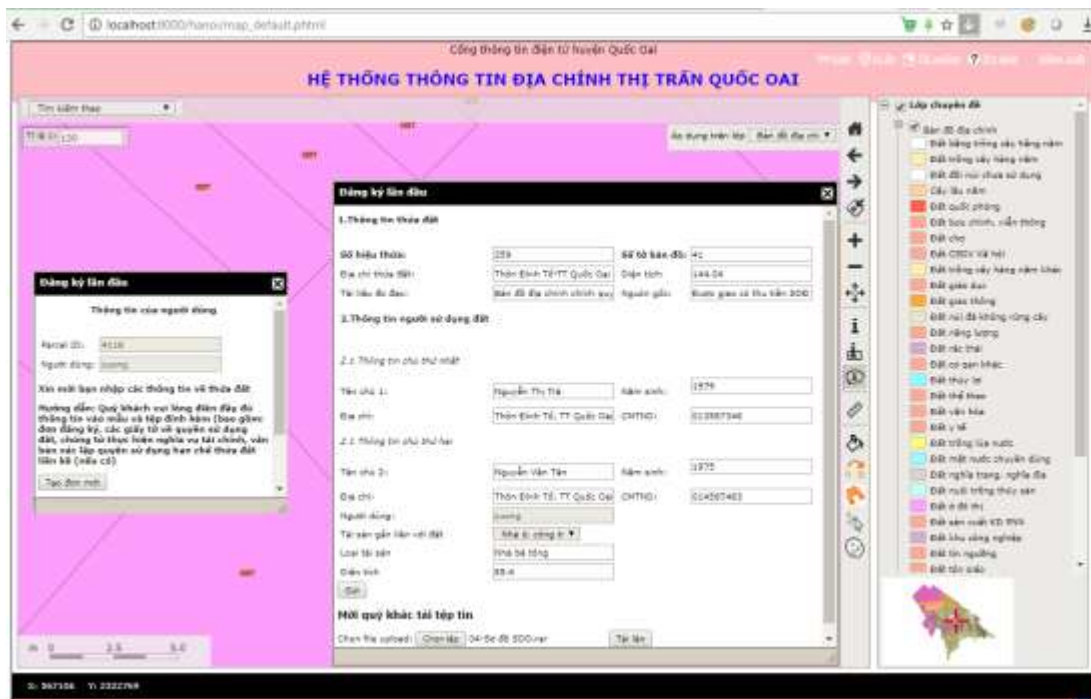
Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

Fig. 1. 9.The first land registration function of the system

d. Evaluate the system test

The system is tested directly with the users and cadres in Quoc Oai town. Specifically, 4 staff working in Quoc Oai town, who are experienced in land management; 5 people who use the system as a guest and 15 people who register an account from the system were involved. The research evaluates the system based on the criteria of interest, necessity, level of expectation, ease of use of the system.

The following table shows the results of four staffs and twenty citizens.

Table 3. Results of the evaluation system

Question	Number answer		
	Yes	No	Can't decide
Are you interested in the system?	19	5	0
Are the provided data sufficient for you?	16	5	3
Does the system make it difficult to use?	3	21	0
Does the function of the system meet your needs?	15	6	3
Do you need help from someone else using your system?	4	20	0
Does the system need to develop more functionality?	18	3	3
Does the system save you time?	24	0	0

The results of the system test show that most of the assessments show the need for a cadastral information system in land registration and the transparency of cadastral information. Although there is a bit of difficulty for those who participate in the assessment as a guest.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

Specifically, nearly 87,5% of the reviews said that the system is easy to use. In addition, about 80% of the system's data reviews are provide at a relatively adequate level. The system not only saves time for land registration activities but also reduces the pressure on the receiving department. Also, some comments suggest that additional land registration functions should be developed, providing additional land price information.

4. CONCLUSION

Establishment of a cadastral database plays an essential role in the registration and certification of cadastral files. In particular, the registration of certification will become easier if the process is carried out online. For developing countries like Vietnam, the costs for proprietary software are creating big barriers, even many programs have to stop. However, with many outstanding features such as the ability to manage good spatial data, support intensive spatial analysis, support many standards for WebGIS,...Therefore, building cadastral information systerm via open source technology illustrate many advatage than exclusive software about prices, easy for edit and improverment. With open source software, the cadastral information system shows many advantages over commercial software in terms of deployment cost and system improvement capability. Although the functionality is limited than commercial software, it is still a good choice regarding the technical infrastructure conditions in Vietnam. The land information system contributes to the transparency of land information, the land registration assistance and the improvement of the cadastral file system.

Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019

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Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
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Hanoi, Vietnam, April 22–26, 2019

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Application of Open Source Technology to Building Cadastral Information System for Land Registration and Complete Cadastral Records System (a Case Study of Hanoi City, Vietnam) (9796)
Quang Cuong Doan, Van Tuan Tran and Khac Hung Vu (Vietnam)

FIG Working Week 2019
Geospatial information for a smarter life and environmental resilience
Hanoi, Vietnam, April 22–26, 2019