



## APPLICATION OF UML LANGUAGE TO DESIGN LAND PRICE INFORMATION SYSTEM IN DAN PHUONG DISTRICT, HANOI CITY

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### Abstract

*Land price is always an issue of concern to society because of its importance in all aspects of life. Currently, the construction of land price information systems is increasingly being developed. Dan Phuong district is a suburban district of Hanoi with a relatively fast development rate. The district still needs to build a land price information system. To make a highly applicable land price information system, designing and modeling the system is extremely important. Currently, there are many applications to create and model databases. For example, the UML language is a popular application that helps users visually identify architecture, design and deploy systems information as quickly as possible. UML is to provide the development community with a popular and stable design language that can be used to develop and build computer applications. UML provides a unified standard modeling notation that information technology professionals have wanted for many years. IT professionals can now read and disseminate system structures and design plans using UML. UML has become a standard modeling language because of its programming language independence. UML is used to design software and information systems in the form of common UML diagrams: use case diagrams, class diagrams, sequence diagrams, state diagrams, activity diagrams, component diagrams, and deployment diagrams. The research used case diagrams to design the land price information system functions and class diagrams to design the land price database. Therefore, we use UML language to create a land price information system and land price database for Dan Phuong district, Hanoi city.*

**Keywords:** Land price; Information system; Data base; UML; Dan Phuong.

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### 1. Introduction

Land price issues are of great concern to the people and the state land management system. Appropriate technical infrastructure is needed to transmit price information to everyone at any time. The Internet has covered all areas, from urban

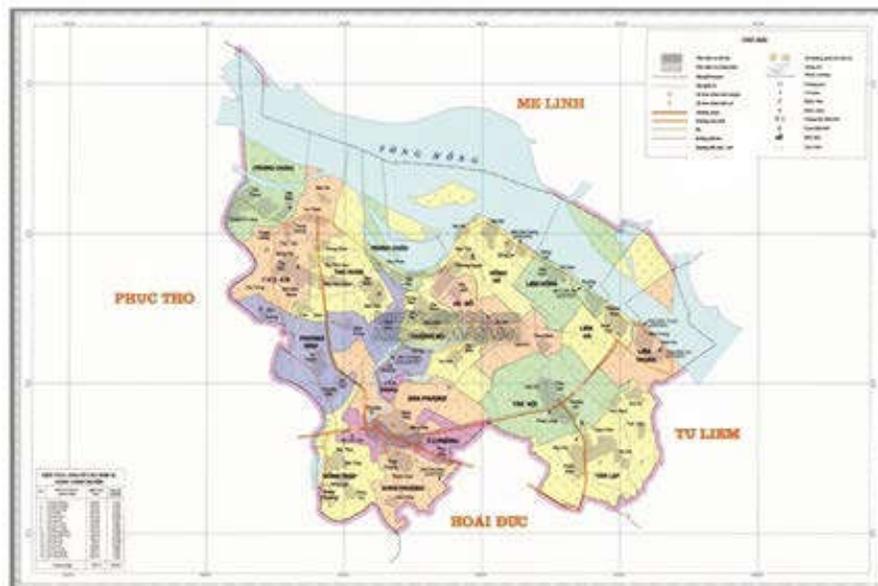
to rural areas, and information technology applications in life are increasingly developing. Combining the Internet and WebGIS systems brings huge benefits. To design a WebGIS, the UML language is a suitable choice to describe the structure and operation of the system [6, 7].

Dan Phuong district, Hanoi city, is considered a hot area of the real estate market compared to suburban districts of Hanoi, thanks to the development of transportation infrastructure and real estate transaction facilities increased quite a lot. An information system that provides data on land prices is needed to serve information needs and manage land prices more effectively. Building a land price information system is necessary. The first job is to design the land price information system and database model.

## 2. Research area

Dan Phuong district is located northwest of Hanoi city center, in the middle of National Highway 32 from Hanoi center to Son Tay, about 20 km from the city center. Dich Vong ward is adjacent to the following units:

- The North borders Me Linh district, with the boundary being the Red River.
- The South borders the Hoai Duc district.
- The East borders Dong Anh district (with the boundary of the Red River) and Bac Tu Liem district.
- The West borders Phuc Tho district with the border of Day River.



*Figure 1: Map of Dan Phuong district*

All primary schools in the district have met national standards. There are densely populated communes, with about 19,000 people in Tan Hoi, 25,000 in Tan Lap, and more than 10,000 in Phung, Hong Ha, and Phuong Dinh towns [5].

## 3. Methodology and data

### 3.1. Research methods

*3.1.1. Methods of collecting and synthesizing secondary data*

Research collects and analyzes documents and legal documents related to land prices, land value areas, and planning orientations of the research area.

According to the state table in Hanoi city in 2020 - 2024, land prices are regulated in Decision No. 30/2019/QĐ-UBND dated December 30, 2019 [4]. In addition, the research also needs to collect spatial data and attribute data on natural, economic, social conditions, and land data

(climate characteristics, soil, etc.), land use situation, sources of land statistics of the district, cadastral maps, current status maps from specialized agencies combined with selective inheritance.

### *3.1.2. Methods of investigation and collection of primary information*

Research to collect information on successfully traded land prices on the market, auction land prices, specific land prices, and factors affecting land prices in Dan Phuong district to ensure a reasonable survey sample size. Allowed accuracy of 5 % according to the following formula:

$$n = \frac{N}{1 + N(e)^2}$$

in which: n is the survey sample size; N is the overall quantity; e is the standard error [8].

### *3.1.3. Integrated approach*

- Summarize the collected data in an Excel table, including numeric and text data.

- Classify numerical data, such as land price, area, etc., in an easy-to-understand table format and encode the text attribute.

### *3.1.4. Structured design approach*

Use the unified modeling language UML to describe the land price database model in Dan Phuong town.

### *3.1.5. Spatial analysis method using GIS*

The spatial analysis method using GIS solves problems related to standardizing map data.

### *3.1.6. Professional solution*

Consult with experts in the field of research, refer to published documents, research, and scientific reports.

## **3.2. Research data**

Research has been conducted to collect spatial data and attribute data collected for research work, including:

(1) Digital cadastral map data of Dan Phuong district. The data includes map fragments of Dan Phuong commune, Dan Phuong district;

(2) Map of current land use status in 2020, scale 1:5,000;

(3) Land use planning map of Dan Phuong district at scale 1:25,000 to 2030;

(4) Survey and field investigation forms (209 survey forms).

The data collected to build a database in the area is still limited. Spatial data still has many errors, and attribute data is not synchronized, so it is necessary to standardize data when building a land price database.

## **4. Results and discussion**

### **4.1. UML language in information system design**

The design of the land price information system is carried out using the UML language (Unified Modeling Language). It is a modeling language of graphical symbols that object-oriented methods use to design information systems quickly.

Building models in UML is very suitable for describing information systems in both structure and operation. The UML model approach benefits those who design and implement the information systems they intend to build. This broad view helps to fully grasp user requirements, from the analysis stage to the design, appraisal, and testing of information technology application products. The established object-oriented models are also the basis for applying automatic code generation programs in object-oriented programming languages [12].

UML uses a unified notation system to represent model elements. Collections of model elements form UML diagrams. There are the following main types of UML diagrams:

- Class Diagram.
- Object Diagram.
- Use Case Diagram.
- Sequence Diagram.
- Collaboration Diagram or Composite Structure Diagram.
- State Machine Diagram.
- Component Diagram.
- Activity Diagram.
- Deployment Diagram.
- Package Diagram [13].

To design the land price information system, we use two types of diagrams: case diagrams and class diagrams.

- Use Case Diagram: The primary purpose of using use case diagrams is to help system developers visualize the functional requirements of a system, including the relationships of “actors” (people or subjects who will interact with each other system) with the necessary processes, as well as the relationships between different use cases. A use case illustrates a unit of functionality provided by the system. To show a use case on a use case diagram, one draws an ellipse in the middle of the diagram and names it in the middle of the figure. To remove a role (actor - equivalent to a type of system user), one draws a person attached to the left or right side of the diagram and then uses simple lines to describe the relationships between the role and use cases..

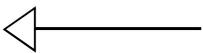
**Table 1. System use case diagram**

Ingredient	Symbol	Describe
Use case		- A function that the system provides.
Actors		- Humans, who will interact with the system.
Usage relationship		- Shows which role (actors) uses which function.

- Class Diagram: is a diagram that gives images of the structural relationships and functional behaviors of classes. A class is an abstraction that emphasizes common properties, ignoring specific properties. An object is an instance of a class. A class

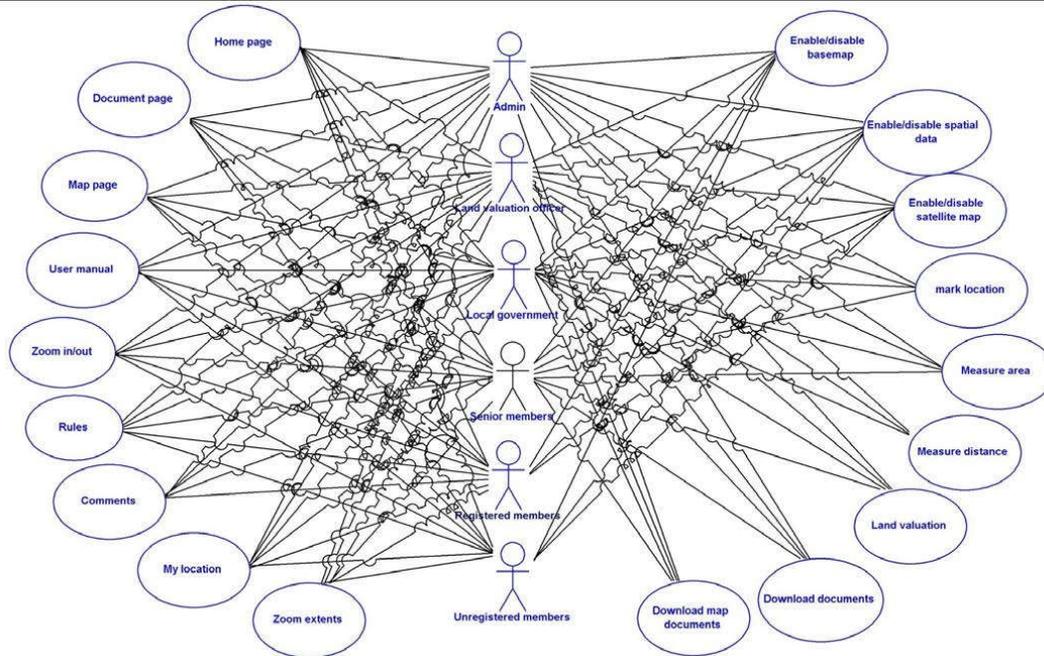
diagram represents a class by a rectangle that displays its name, operations, and attributes. The class name is required, and methods and properties may or may not be expressed. Class diagrams are often used to design databases for information systems.

**Table 2. Components in the class diagram**

Ingredient	Symbol	Describe
Class		- Representing entities: People, topics, and data.
Affiliate relationship		- Shows the relationship between classes.
Inheritance relationship		- Shows inheritance relationships between classes. A child class will inherit all properties of the parent class.

#### 4.2. Use case diagram and functions of the land price information system

We identify 6 groups of actors in the land price information system: unregistered members (walk-in guests), registered members (people), senior members, the local government, including local land price managers, land valuation staff, and system administrator. Users of the system's functions are as follows:



**Figure 2: Use case diagram of the land price information system**

The local government group is the managers in localities, including the General Department of Land Management, Provincial People's Committee, Department of Natural Resources and Environment, and other managers (Land Use Rights Registration Office, Department of Finance),...or can be understood as officials of the state price management agency or the agency with the function of state price management at the central and local levels. Responsible for updating the land price database as follows:

- Update information about human resources under management.
- Manage delegate authority to update, exploit, and use land price database.
- Update land price frame data, land price list, specific land prices, adjustment

coefficients, and market land prices in the land price database.

- Determine the time limit for updating land price frame data and land price list from the decision date to enter the land price database.
- Carry out land valuation using the following methods: A direct comparison, deduction, collection, collection, adjustment coefficient, standard plot reference (mass valuation), and updating the land price database.
- Manage, check, and update land price data to the official database, valuation results of independent valuation agencies as well as other related data.

The land valuation staff of the group is an officer directly involved in land valuation work and is responsible for complying with regulations on updating the land price

database of the local government group. Can perform land valuation functions, including land valuation using the direct comparison method, land valuation using the deduction method, land valuation using the income method, and land valuation using the adjustment coefficient method correction. Land prices after valuation can be updated in the database to enable further valuation work. However, this price has yet to be included in the official database but only in the temporary database. Only when the Local government group conducts price censorship will it decide whether to include the price that the Land valuation staff of the group has determined in the official database.

The System Administration group is the person who directly administers the system. They are responsible for

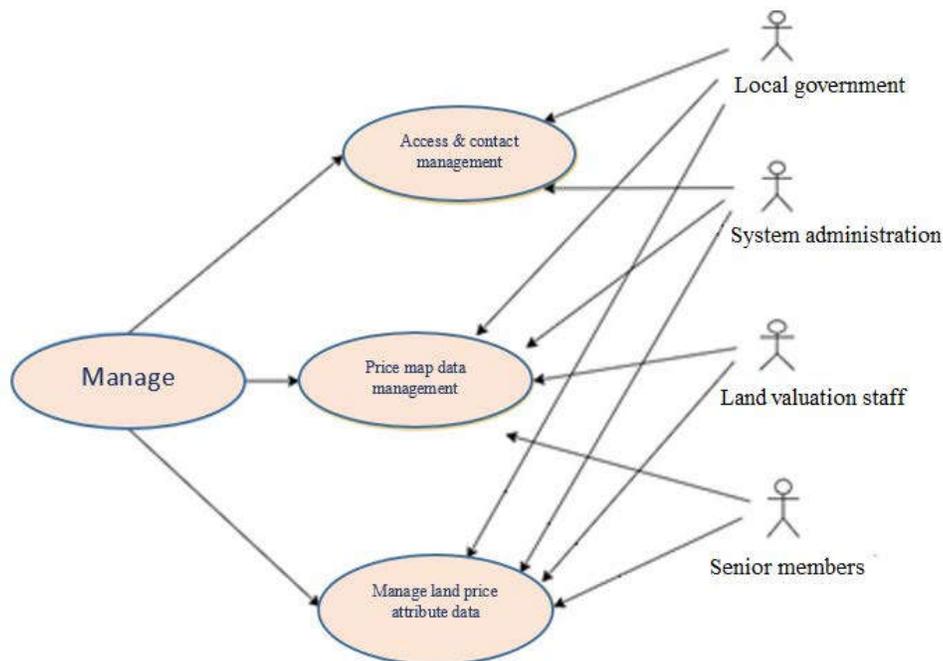
maintaining systems, backing up data, and managing members.

The Senior Members group has the highest access rights to most system functions. They can access highly detailed data.

The Registered Members group (People) register and can access some system functions. They can look up basic information, exchange information with other members, and provide specific land price information and transaction land prices to update the land price database.

The Unregistered Members group (walk-in guests) do not register and can only use very few system functions.

There are 3 groups of functions (authorities): Land price database management; Access and exploit land price database; Update land price database.



**Figure 3: Use case diagram of land price information system management function**

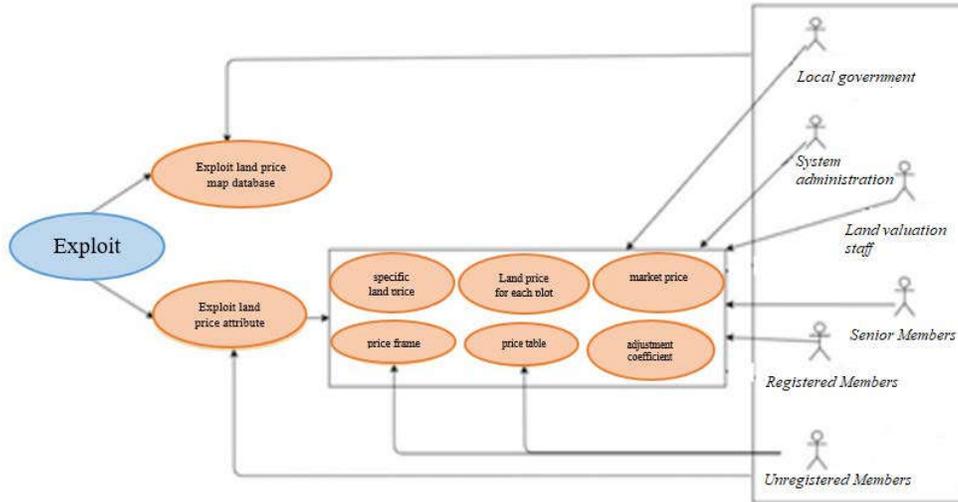
From the user group, the subjects participating in the management and exploitation of the land price database are arranged according to the following levels:

- Level 1 member: Local government group.
- Level 2 member: System administration group.

- Level 3 member: Land valuation staff of the group.
- Level 4 member: Senior Members group.
- Level 5 member: Registered Members group.

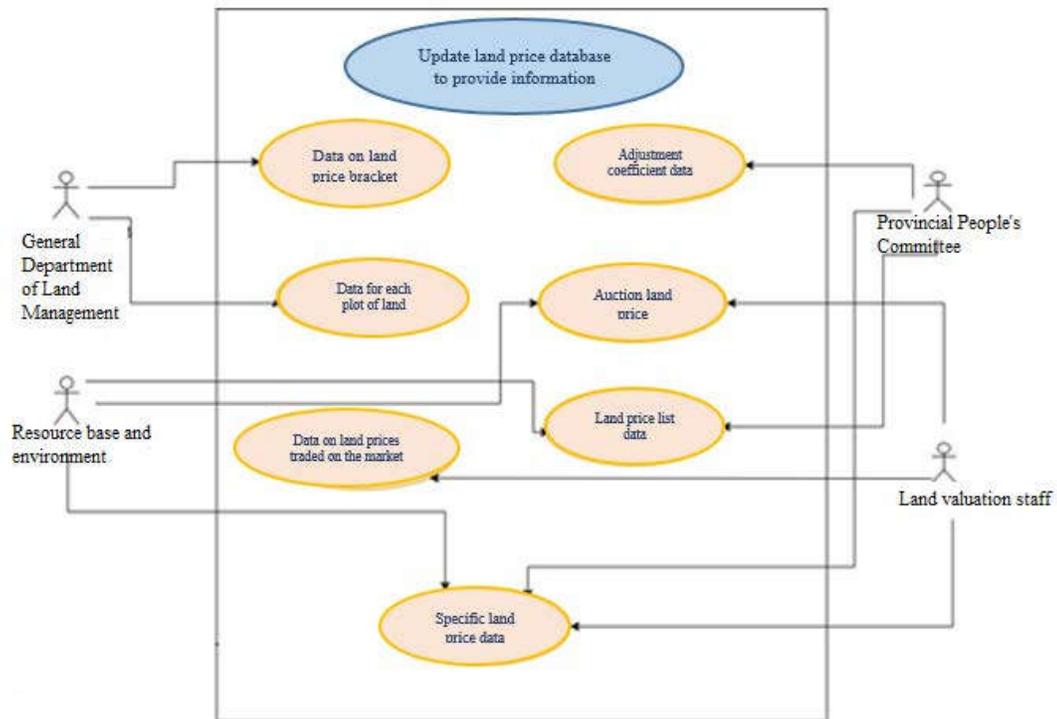
- Level 6 member: Unregistered Members group.

Among the 6 levels of membership, members of levels 1,2,3,4 are the administrators, operators, and developers of the land price information system. Members 5 and 6 are simply database operators.



**Figure 4: Use case diagram of the information extraction function of objects**

When updating the land price database on the system, based on authority and responsibility, the subject will have specific rights:



**Figure 5: Use case diagram for updating land price database**

### 4.3. Design of land price database

Based on the system's functions and operations analysis, the land price database model has been designed as a class diagram. In this diagram, each data table is represented by a class, arrows represent generalization relationships (inheritance), and straight lines represent association relationships between data tables (or data classes). Detailed information about the data layers is presented in Table 3. Because most current database management systems do not support Vietnamese, the names of classes and their attributes are expressed in Vietnamese without accents [1].

The ancestors of all classes in the database are objects and spaces. The object has a unique attribute, object\_id (identification - the object's identification number). With such a design, all classes in the database have an id attribute [9].

Data classes that only have attribute information (user, place name, etc.) will inherit from the object\_id class, while data classes that have spatial information (land plot, road traffic,...) will inherit from the space\_space class. This is a subclass of the object class (object\_id) with an additional geo attribute field (the geometry) to describe geometric information.

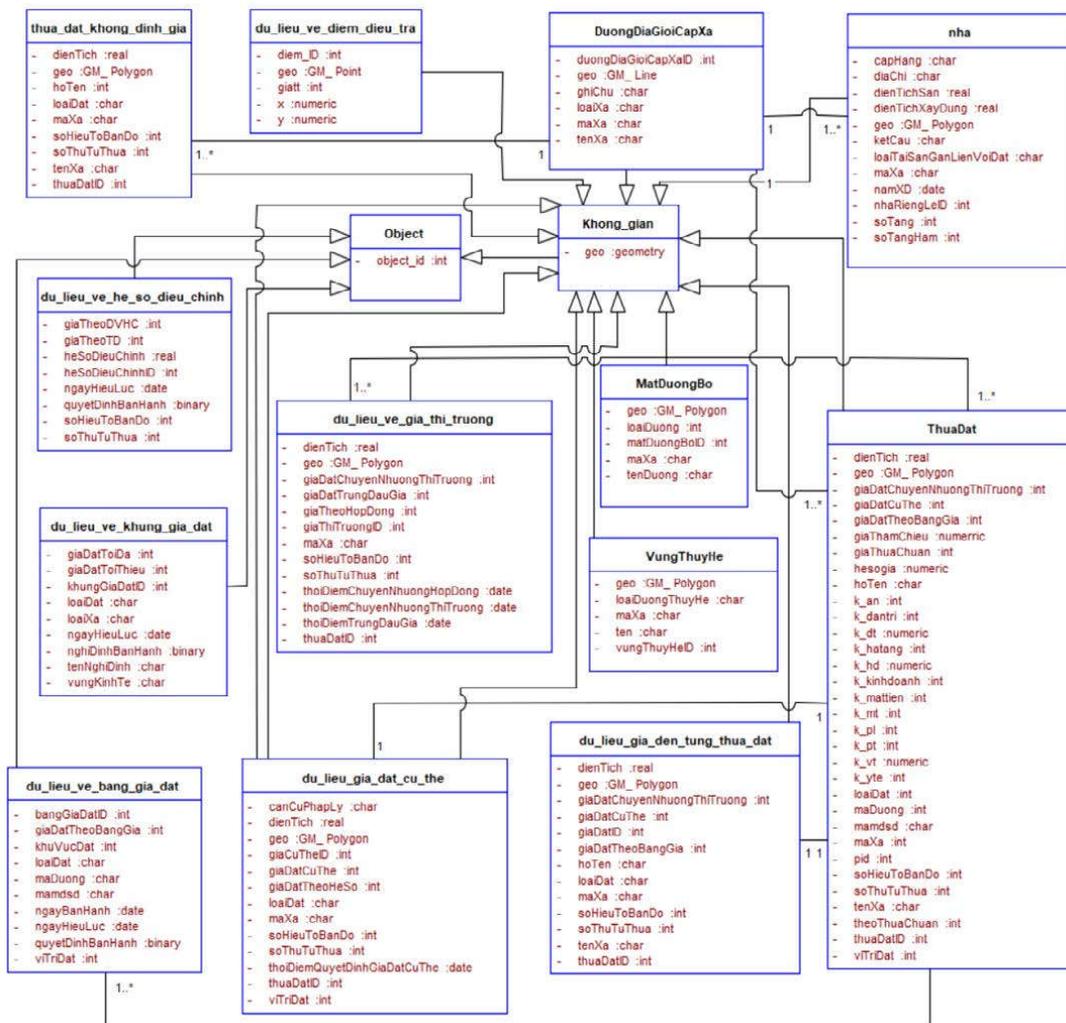


Figure 6: The database model is represented by a class diagram [2]

The database shows cadastral information in the tables “thang\_dat”, “dang\_ky\_sdd”, “nsd\_dat”. The database model for the cadastral information block is designed based on the model of the Ministry of Natural Resources and Environment [2].

Information on land prices is shown in 6 tables: “du\_lieu\_ve\_he\_so\_dieu\_chinh”, “du\_lieu\_ve\_khung\_gia\_dat”, “du\_lieu\_ve\_bang\_gia\_dat”, “du\_lieu\_ve\_gia\_thi\_truong”, “du\_lieu\_gia\_cu\_the”, “du\_lieu\_den\_tung\_thua\_dat”. Table “du\_lieu\_ve\_he\_so\_dieu\_chinh” stores information on land price adjustment coefficients for Hanoi City People’s Committee to regulate, table

“du\_lieu\_ve\_khung\_gia\_dat” stores information about land price frames prescribed by the Government for each region, table “du\_lieu\_ve\_bang\_gia\_dat” stores information about the systems Land price adjustment number for Hanoi City People’s Committee to stipulate. Table “du\_lieu\_ve\_gia\_thi\_truong” shows data predicting market land prices after calculation, “du\_lieu\_gia\_cu\_the” stores information about specific land prices in the area, “du\_lieu\_den\_tung\_thua\_dat” stores information about types of land prices determined for each land surplus in the research area.

The land price database components in the class diagram are shown in Table 3.

**Table 3. Contents of land price database**

Table name	Content	Important attributes
ThuaDat	Description of land plots	thuaDatID, maXa, TenXa: object code, commune code, commune name. soHieuToBanDo, soThuTuThua, trangThaiDangKy, dienTich, mamdsd: Map number, plot number, registration status, area, land use code. hoTen: User name. k_vt, k_dt, k_hd, viTriDat: location coefficient, area coefficient, shape coefficient, land position. giaDatTheoBangGia, pid, theoThuaChuan, giaDatChuyenNhuongThiTruong, giaDatCuThe: Land price according to price list, standard plot, land plot priced according to standard plot, land transfer price on the market, specific land price.
nha	Description of home	taiSanID, maXa: object code, commune code. dienTichXayDung, soTangHam, dienTichSan, capHang, diaChi: Construction area, number of basements, floor area, grade, address. thuaDatID, loaiTaiSanGanLienVoiDat, tenTaiSan, KetCau, NamXD, SoTang, geo: Plot object code, asset type code attached to land, asset name, house structure, year of construction, number of floors, graphic data.
DuongDiaGioiCapXa	Commune-level boundary line	diaPhanCapXaID, maXa, tenXa, LoaiXa: Object code, commune code, commune name, commune type. dienTichTuNhiem, ghiChu, geo: Natural areas, notes, graphic data.

Table name	Content	Important attributes
MatDuongBo	Road description	gid, loiDuong, tenDuong: object code, road type, road name. ChieuDai, DiemDau, DiemCuoi, DoRong, geo: line length, start point, end point, width, graphic data.
VungThuyHe	Description of Water system	duongThuyHeID, ten, loiDuongThuyHe: Object code, water system name, line water system type. ChieuDai, DiemDau, DiemCuoi, DoRong, geo: length, start point, end point, width, graphic data
Thua_dat_khong_dinh_gia	Description of land plots without land valuation	thuaDatID, maXa, soHieuToBanDo, soThuTuThua, dienTich_PL, dienTich, loiDat, geo: Object code, commune code, map number, land parcel number, legal area, area, land type, graphic data.
du_lieu_ve_diem_dieu_tra	Information about land price key points	Diem_ID, X, Y, Gia: Information points, X coordinates, Y coordinates, investigation price.
du_lieu_ve_gia_thi_truong	Data on land prices traded on the market	giaThiTruongID, giaTheoHopDong, thoiDiemChuyenNhuongHopDong: Object code, land price according to transfer contract, time of transfer according to contract. giaDatTrungDauGia, thoiDiemTrungDauGia: Land price winning auction, time of winning auction. giaDatChuyenNhuongThiTruong, thoiDiemChuyenNhuongThiTruong: Market land transfer price, transfer time. loiDat, maXa, soHieuToBanDo, soThuTuThua, dienTich, hoTen: Land type code, commune code, map number, plot number, area, name of owner.
du_lieu_ve_khung_gia_dat	Data on land price bracket	khungGiaDatID, ngayHieuLuc, nghiDinhBanHanh, vungKinhTe, tenNghiDinh: Object code, effective date, decree issued, economic region, decree name. giaDatToiThieu, giaDatToiDa, loiDat, loiXa: minimum price, maximum price, land type, commune type.
du_lieu_ve_bang_gia_dat	Land price list data	bangGiaDatID, ngayBanHanh, quyetDinhBanHanh, ngayHieuLuc: Object code, issuance date, issuance decision, effective date. viTriDat, giaDatTheoBangGia, khuVucDat, mamdsd, maDuong: Land location, price according to land price list, land area, use code, road code.
du_lieu_gia_cu_the	Specific land price data	giaCuTheID, giaDatTheoHeSo, giaDatCuThe, canCuPhapLy, thoiDiemQuyếtDinhGiaDatCuThe: object code, land price according to land price adjustment coefficient, specific land price, time to decide specific land price, legal basis, time to decide specific land price. thuaDatID, maXa, soHieuToBanDo, soThuTuThua, loiDat, dienTich, hoTen, maDuong, viTriDat: Land parcel code, commune code, map number, plot number, land type code, area, full name of owner, street code, land location.

Table name	Content	Important attributes
du_lieu_den_tung_thua_dat	Data for each plot of land	giaDatID, soHieuToBanDo, soThuTuThua, thuaDatID, maXa, loaiDat, dienTich, hoTen: Object code, map number, plot number, land parcel code, commune code, land type code, area, name of owner. giaDatCuThe, giaDatChuyenNhuongThiTruong, giaDatTheoBangGia, tenXa, geo: Specific land prices, transfer land prices on the market, land prices according to the state price list, commune names, graphic data.
du_lieu_ve_he_so_dieu_chinh	Adjustment coefficient data	heSoDieuChinhID, heSoDieuChinh, ngayHieuLuc, quyetDinhBanHanh: Object code, land price adjustment coefficient, effective date, issuance decision. giaTheoDVHC, giaTheoTD: Land price by administrative unit, price by land plot. soThuTuThua, soHieuToBanDo: plot number, map number.

After using UML to design a land price information system in the Dan Phuong district, the research team proceeded to build a land price information system in the Dan Phuong

district. The Dan Phuong district's land price information system was constructed to serve the management process, land price transparency, and real estate market development (Figure 7).



Figure 7: Home page interface of the land price information system [4]

## 5. Conclusion

The research used case diagrams to design the functions of the land price information system including 6 groups:

- (1) The local government group includes local land price managers,
- (2) the land valuation staff of the group,
- (3) the System administration group,
- (4) Senior

member group, (5) Registered member group (people), (6) unregistered members group (walk-in guests).

These six user groups are designed and divided to ensure full functions of administration, updating, operating, developing, and exploiting the land price database. Research and create the land price database according to the information layering diagram. Accordingly, we have designed several basic data tables, such as the tables of Land Plots, Houses, Traffic, Water Systems, and investigation points,.... In addition, 6 detailed database tables about land prices are also designed: (1) *du\_lieu\_ve\_he\_so\_dieu\_chinh*, (2) *du\_lieu\_ve\_khung\_gia\_dat*, (3) *du\_lieu\_ve\_bang\_gia\_dat*, (4) *du\_lieu\_ve\_gia\_thi\_truong*, (5) *du\_lieu\_gia\_cu\_the*, (6) *du\_lieu\_den\_tung\_thua\_dat*. Applying UML to design functional systems and land price databases helps analysts have a more intuitive view of the land price database, better serving the work of building a land price information system.

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