APPLICATION OF WEB-GIS TO CONSTRUCT AN ONLINE MAP OF THE ECOPARK URBAN AREA, VAN GIANG DISTRICT, HUNG YEN PROVINCE

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ABSTRACT

In the fourth industrial revolution, the use of the internet is indispensable in managing and sharing information of a country or a locality. Along with the strong development of the internet system and the need to share and look up information on the internet, the integration of GIS technology and web technology (WebGIS) is progressively and widely used. Online maps built with WebGIS have the advantages of ease of use, a large number of users, and providing support in managing, searching, and exploiting information anytime, anywhere. This study aimed to apply GIS technology to build a spatial database to manage nine layers of information about the Ecopark urban area, including housing, apartments, utilities, functional areas, traffic, rivers, canals, construction works, and planning areas. The programming languages HTML, CSS, PHP, and Google Maps JavaScript API were used to build an online map of the Ecopark urban area, and to manage 24 layers of objects according to their functions and purposes for residents and visitors at the website https://ecopark.timoday.edu.vn. This result will be the foundation for Ecopark urban area to develop a smart city in the future.

Keywords: Google Maps JavaScript API, GIS, WebGIS.

Ứng dụng webgis xây dựng bản đồ trực tuyến khu đô thị Ecopark, huyện Văn Giang, tỉnh Hưng Yên

TÓM TẮT

Trong cuộc cách mạng công nghiệp lần thứ tư, việc sử dụng internet là không thể thiếu trong việc quản lý và chia sẻ thông tin của một quốc gia, một địa phương. Cùng với sự phát triển mạnh mẽ của hệ thống internet và nhu cầu chia sẻ, tra cứu thông tin trên mạng, việc tích hợp công nghệ GIS và công nghệ web (WebGIS) ngày càng được sử dụng rộng rãi. Bản đồ trực tuyến xây dựng bằng WebGIS có ưu điểm là dễ sử dụng, số lượng người sử dụng nhiều, hỗ trợ quản lý, tra cứu và khai thác thông tin mọi lúc, mọi nơi. Nghiên cứu này nhằm ứng dụng công nghệ GIS để xây dựng cơ sở dữ liệu không gian nhằm quản lý chín lớp thông tin về khu đô thị Ecopark, bao gồm nhà ở, chung cư, tiện ích, khu chức năng, giao thông, sông rạch, công trình xây dựng và khu quy hoạch. Các ngôn ngữ lập trình HTML, CSS, PHP và JavaScript API của Google Maps được sử dụng để xây dựng bản đồ trực tuyến khu đô thị Ecopark và quản lý 24 lớp đối tượng theo chức năng và mục đích sử dụng cho người dân và du khách tại website https://ecopark.timoday.edu.vn. Kết quả này sẽ là tiền đề, nền tảng để khu đô thị Ecopark phát triển thành thành phố thông minh trong tương lai.

Từ khóa: Bản đồ trực tuyến, GIS, WebGIS.

1. INTRODUCTION

Along with the development of hardware, software, and internet technology, current mapping applications are not only running on computer desktops but are also being developed to run on web environments, and WebGIS is a very popular choice for the development of online mapping (Anuj & Kamal, 2017). WebGIS is a client - server solution that allows the management, analysis, updating, and distribution of map information and GIS on the

internet (Pan *et al.,* 2010; Tran Nam Phong *et al.,* 2014), while minimizing the costs of software and hardware investments for users. In addition, it has a simple and friendly interface that is suitable for many users. WebGIS is suitable for spatial databases from small to very large, is highly customizable, and is appropriate for many types of organizations (Adnan, 2010). WebGIS has great potential in making geographic information useful and available to enormous numbers of users around the world. With the use of online maps, users will be able to utilize and update data on maps to serve the retrieval and collection of information. Several published works have dealt with constructing databases in smart cities, including Miltiadis *et al.* (2021) who demonstrated how to manage information for all the stakeholders' benefits while making a smart city, and Byungjun *et al.* (2021) who aimed to specify civic demands and forecast the demands of Seoul citizens by analyzing 160,000 civic queries over 10 years.

The Ecopark urban area is a new ecological urban area that was formed in 2009. It is located in Van Giang district, Hung Yen province, with an area of about 500 ha. This is an urban area that residents are very satisfied with, and features a green, clean, beautiful living environment, lots of trees, lots of shade, and many spacious amusement parks and facilities. Besides, investors in the Ecopark urban area always seek new solutions for residents to continue developing towards a modern, civilized urban area. Strategic developers of urban areas have ideas to promote the application of information technology, digital technology, and the internet to create smart gadgets to support residents in Ecopark. Therefore, the demand for information about Ecopark through internet searches in recent times is very high. This is a very impressive point to attract people to such an urban area.

Faced with actual demand, this research had the objectives of building an Ecopark map database and using the WebGIS-based application to provide information to anyone who wants to know more about Ecopark.

2. METHODOLOGY

2.1. Data collection

Maps of Ecopark were collected from available resources, such as Ecopark's administrator and the local authorities of Van Giang district, Hung Yen province. The maps described the boundaries of all the subdivisions of Ecopark, with detailed design drawings of the whole urban area. Nineteen areas have been built within Ecopark, while the remaining areas are in the process of applying for approval and have not been built.

In addition, a field survey was done by using GPS devices with an accuracy of 8 meters to collect information about the addresses of each house, apartment, entertainment spots (parks, swimming pools, golf club, etc.), businesses (shops, restaurants, bars, coffee shops, etc.), public transportation (bus stops), ATMs, etc.

2.2. Data standardization

All collected spatial data were transformed to the global coordinate system WGS84. For design drawings which were in the local coordinate system, the conversion to WGS84 was done using control points. Consequently, the spatial data were standardized according to the regulations of the Ministry of Natural Resources and the Environment using ArcGIS software.

2.3. Constructing the spatial database

ArcGIS software was used to standardize the maps and attribute tables for nine layers in the shapefile format (*.shp), namely housing, apartments, utilities, functional areas, transportation, rivers, canals, planning areas, and buildings.

2.4. Constructing WebGIS

Data from the internet were transmitted using HTML and CSS language, programming scripts based on available objects used Javascript language, and PHP (Hypertext Preprocessor) language was used to program

and develop the open source applications (Michael, 2014).

The online maps of Ecopark were built using Google Maps JavaScript API, which is a support application for developing maps provided by Google. It allows the user to customize content and images of maps displayed on the web page (Bildirici & Ulugtekin, 2010).

These were the necessary and common methods to build a map database, build a website, and share the data on the web.

3. RESULTS AND DISCUSSION

3.1. Construction of the spatial database

In order to facilitate the updating and processing of data, maps after standardization were divided into groups of data layers to serve different purposes. According to actual requirements, the data were classified into nine layers: houses, apartments, utilities (restaurants, banks, bus stops, etc.), functional areas (trees, parks, schools, sports fields, etc.), transportation, rivers, irrigation (irrigation, lakes), work (address, area), and planning areas (Table 1).

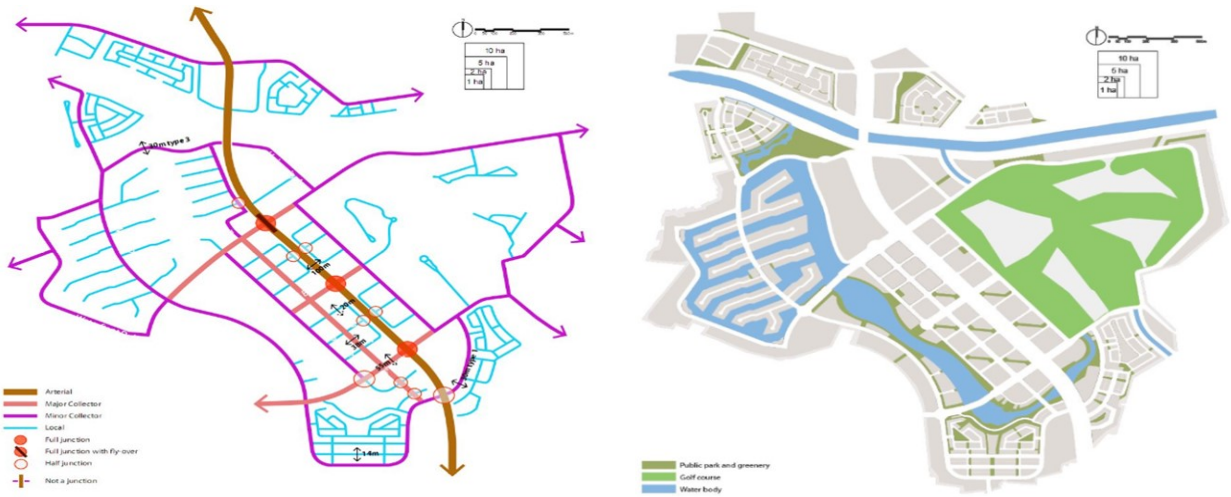
Corresponding to each spatial data layer (Figure 1) was a customized attribute data table, which included the required fixed fields and flexible declaration fields. Fixed fields were required for the identifying information on a parcel (parcel number, house number, type of property, name of the subdivision, etc.). Mutable information (owner, purpose of use, number of permanent members, etc.) will be updated on a regular basis when there is a change in registration. In addition to the data layers for information exploitation, there were also some other layers for the purposes of illustration and annotation on the website.

The Ecopark spatial database initially had nine basic data layers. However, depending on the purpose of exploitation, management, and use in the future, it would be possible to establish more intensive data layers for each management department. The map of Ecopark urban area overlaid on the satellite image is shown in Figure 2.

3.2. Construction of the online spatial database

3.2.1.Designing the database model

To store the map layers and attribute data, a database was designed to store the attribute data and spatial data (Figure 3).



(A)Transportation layer (B) Water layer

Figure 1. Spatial data layers for (A) transportation and (B) water

Table1. Spatial data layers for information exploitation

Name of spatial data layers	Type	Description
Houses	Polygon	Houses, shop houses
Apartments	Polygon	Design, floors, spatial distribution of the ground floor of each apartment
Utilities	Point	Available utilities (banks, bus stops, restaurants, and bars, etc.)
Functional areas	Polygon	Functional areas (schools and sports fields, etc.)
Transportation	Polygon	Transportation
Rivers	Polygon	Natural water bodies
Canals	Polygon	Artificial water bodies
Planning areas	Polygon	Unbuilt areas
Buildings	Polyline	Detailed design drawings of each parcel

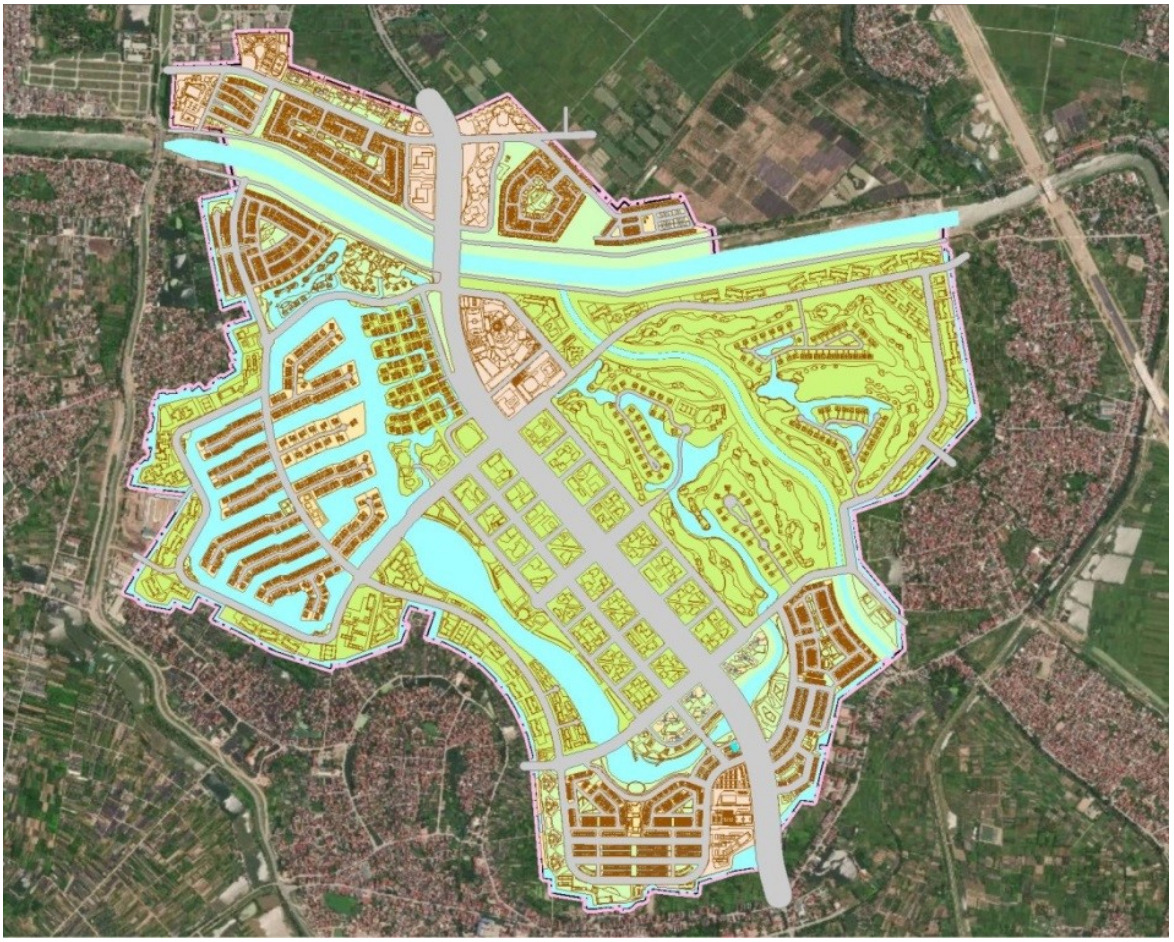


Figure 2. Map of Ecopark overlaid on the satellite image

The tables in the model each served a specific function as follows:

- Table tblphanloai classified objects that will be displayed on the user interface such as ATMs, entertainment spots, houses, apartments, car parks, etc.

- Table tblvitri stored point data describing the detailed location of each object.

- Table tblanh allowed for the attachment of several pictures to each location.

- Table tblvung stored polygon data describing the location, shape, and design of the buildings.

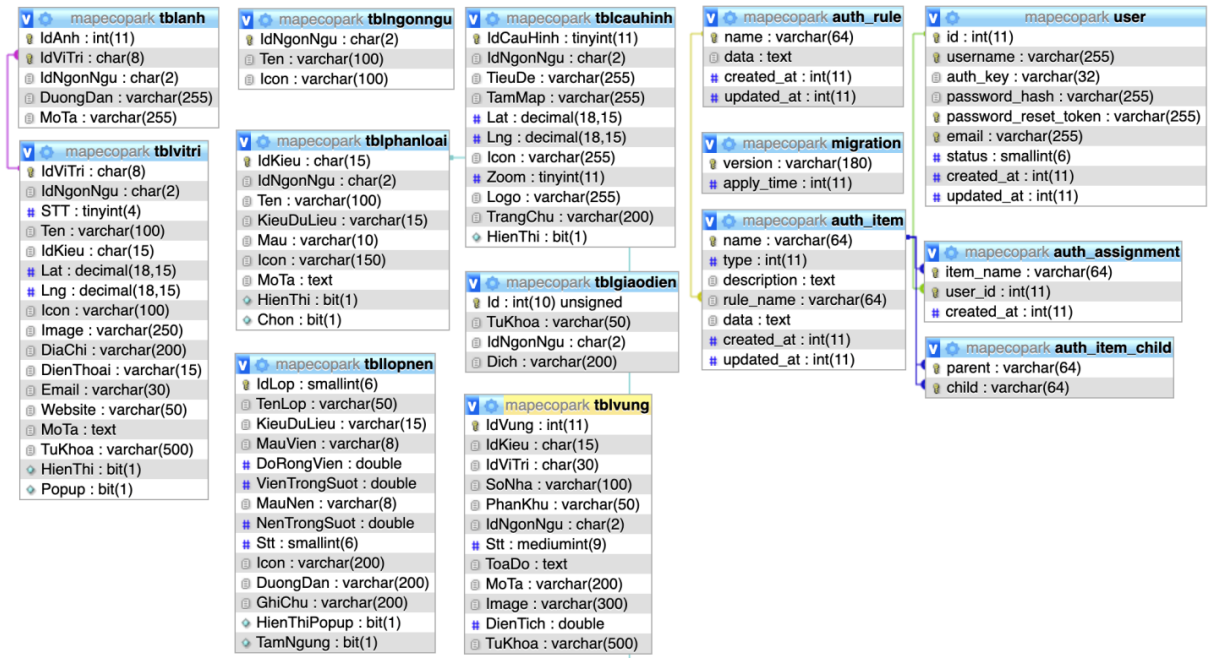


Figure 3. WebGIS database model

- Table tbllopnen allowed for the integration of background data layers into the general map of the system such as layers of roads, boundaries, trees, etc.

- Tables tblgiaodien, tblngonngu, and tblcauhinh were used for setting up dynamic interfaces and configuring the parameters for the system.

- Tables user, auth_rule, migration, auth_item, auth_item_child, and auth_assignment were used for user storage and user authorization.

3.2.2. Designing interface and functionality on the web

The interface of the website was designed to ensure user-friendliness by using icons to describe objects on the maps and making it easy for users to recognize real objects. Advanced design technology was applied to create an interface that is compatible with different devices - responsive web design (Responsive Web).

Functions for users: The nine data layers in GIS were divided into 24 object classes according to the functions and purposes of users on the user interface, such as food, parking, swimming pools, coffee shops, ATMs, banks, bus stops, apartment buildings, townhouses, etc. Objects were symbolized by icons and colors for users to quickly identify objects on the map (Figure 4).

Functions for administration: To help administrators update and supplement the WebGIS data easily, the following basic functions were critical parts of the WebGIS system:

- Security management: user management and authorization for users;

- Site management: ability to manage the configuration for all web applications such as display language for the web, interface, and configuration parameters; and

- Managing list: ability to update the layers of the base map, locations, and areas (Figure 5).

However, the accuracy of the GPS device in this study was 8 m, which made it quite difficult to locate some objects precisely.

3.3. Utilizing the WebGIS Database

After completing the division of the database to WebGIS, the use of the database is

easy and convenient to operate and utilize when there is internet.

Function for viewing detailed information of objects: Basic information of the objects will be displayed on the dialog box when the object is clicked on (Figure 6).

Function for searching data based on its attribute information: Ajax technology helps to create a user-friendly search interface: when you type some characters, the dialog box will show some of the closest suggestions, and the results will be displayed on the page without reloading (Figure 7).

Routing function: To determine the route to a location in the area, first, the destination needs to be determined, and then the departure point. The departure point can be "my location" or any user-defined location (Figure 8).

Virtual traveling function through pre-defined points: This function guides the route through certain tourist spots or through predefined points.

Figure 4. Spatial data layers of the online map of Ecopark

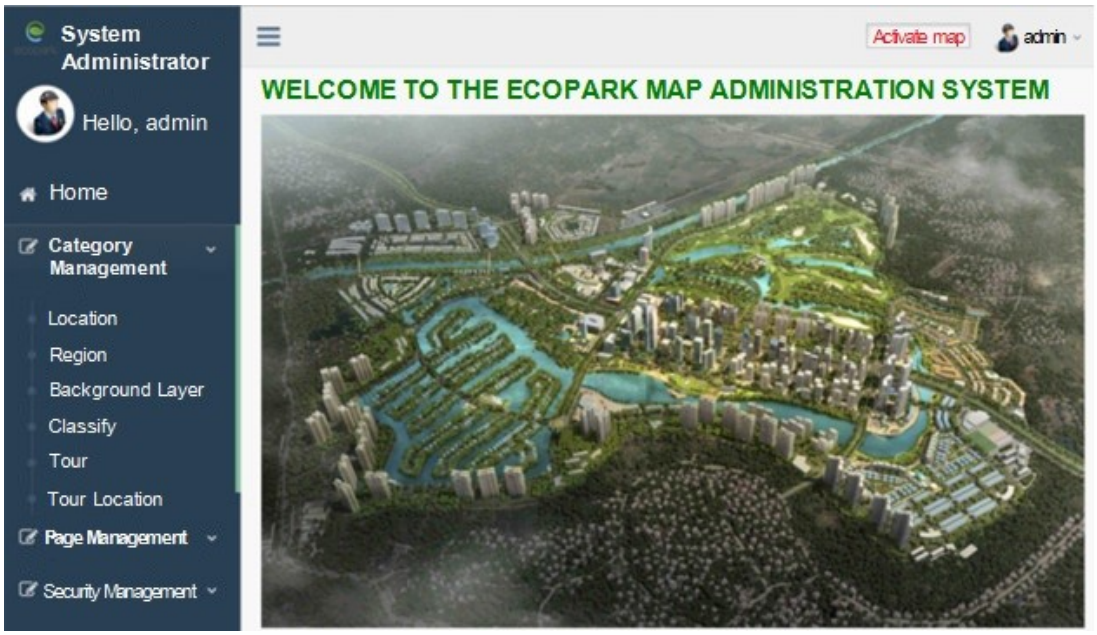


Figure 5. Functions for administration

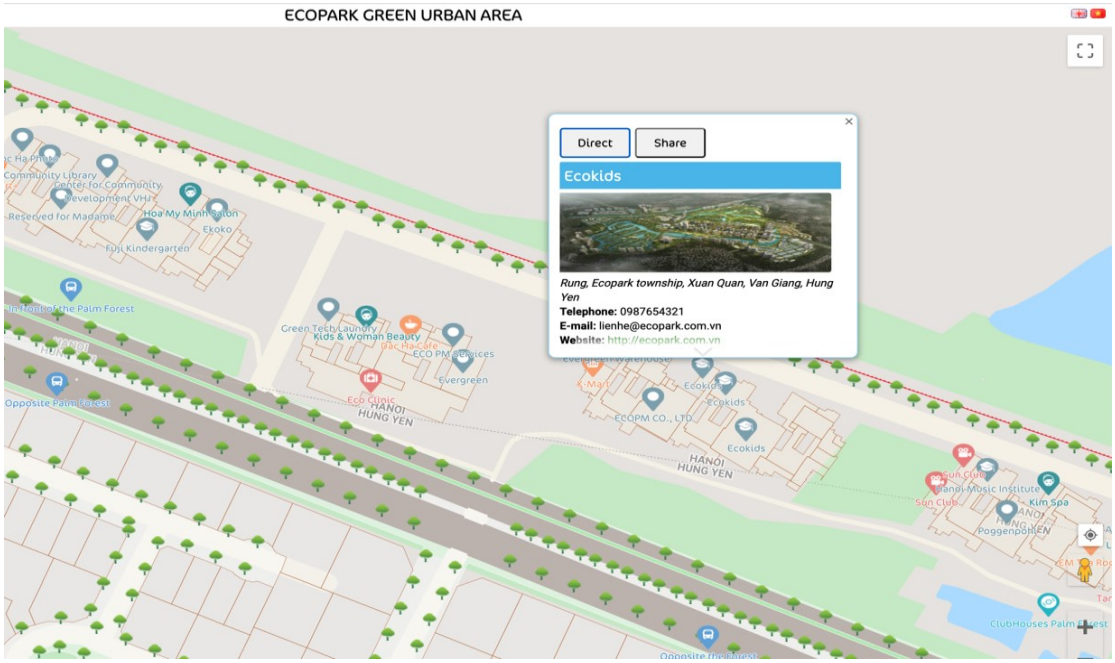


Figure 6. Function for viewing detailed information of objects in the online map

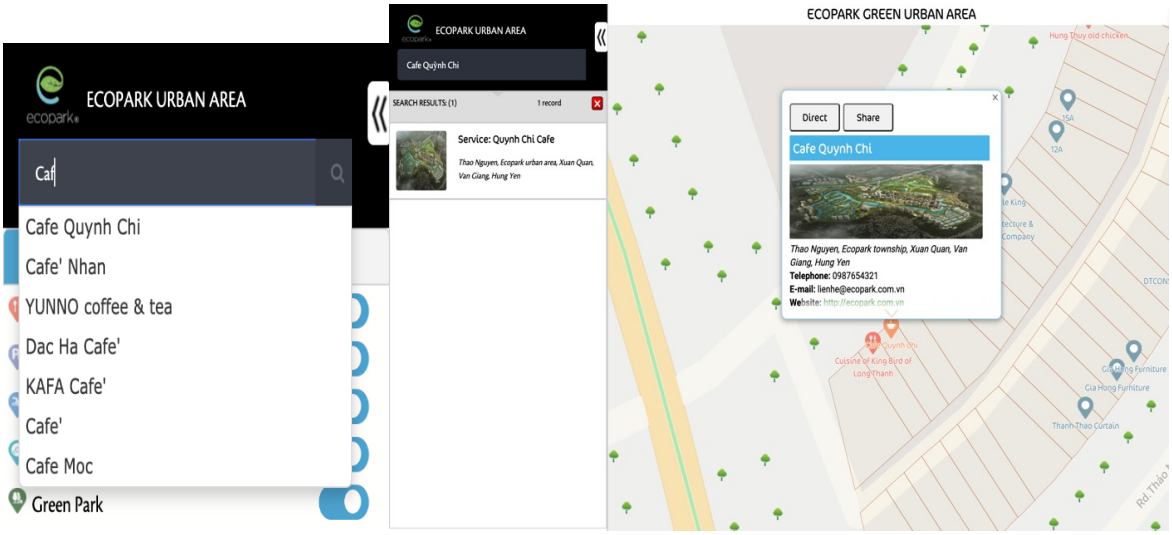


Figure 7. Function for searching data on the online map

4. CONCLUSIONS

The GIS database of the Ecopark urban area was built on the principles of GIS including nine spatial layers and their attributes: houses, apartments (2619 land plots of apartment buildings, townhouses), utilities, functional areas (441 service points), transportation, canals, rivers, planning areas, and buildings. The developed online map was able to manage 24 layers of objects according to their functions and purpose of use, and was posted on the website https://ecopark.timoday.edu.vn to help residents, visitors, and local managers to manage, search, manipulate, and update information. This base database can also be used to continue developing many useful applications to serve urban managers, businesses, and scientists in order to develop smart urban solutions in the future.

Figure 8. Routing function in the online map

Furthermore, in the future, the database constructed in this study can be integrated in a smartphone application, which would help residences easily explore the information.

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