

# Developing the GIS-Expert System for Investigating Land Use Designations

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## Abstract

In order to get the building construction permit, the building owners who intend to construct or modify their buildings must submit documents to the local government officers for approval. Typically, the government officers will review the submitted documents and check city planning and land uses designations in accordance with laws and regulations of each area. This work is burdensome and takes a long time so as to check documents. Moreover, it requires the officers who have enough expertise and comprehend in legislation for the considered building and area information. In case of the officers do not consider all associated regulations or conditions such as width of road in front of the proposed construction area or restricted areas, it will lead to incorrect results of land use and construction approval. Then, the owners of building and land will be affected by such mistakes. Therefore, the research aims to develop the prototype expert system which can support the local government officers and land owners for checking the land uses designations before submitting the building construction permit. This prototype system was integrated laws and regulations with GIS database, Google Map, for retrieving, analyzing, and providing the results via Internet Web Browser. The selected area is Pattaya city in Thailand because it is the one of the most famous cities which has a high level of growth rate of land development. The proposed system can conveniently and efficiently provide the accurate land use information to officers, investors, and also inhabitants.

## Keywords –

GIS, Expert system, Land use

## 1 Introduction

To get the building construction permit, the building owners who intend to construct or modify their buildings must submit building documents to the local

government authorities for approval. Typically, the government officers will review the submitted documents and check principle city planning and land uses designations in accordance with laws and regulations of each area. Checking city planning and land uses designation is the free of cost service which the government provides to residents because it is difficult for the ordinary people to seek and consider all related laws and regulations especially in the special areas. Only the government officers who have knowledge and experiences are capable to perform this task. In mentioned situations, the misunderstanding and human error may lead to the incorrect results and impact to the intended construction project.

The procedure for investigating the land use designation is as follows and shown in Figure 1. Total duration to carry out this procedure is approximately four working days.

1) Clients submit the request form for checking the land use designations to the local government authorities.

2) The government authorities obtain the information from the request form which is the identification number of land parcel, type of intended construction building, and name of adjacent road.

3) The government authorities check the location of this land parcel to identify the city planning zone which determine type of building that allow to construct in this area. In case that the building as clients' requirement is allowed to construct in this area, the government authorities have to verify the width of adjacent road, distance between this building and the road in front of the land parcel for checking the allowable height of the building. There are at least three important conformed laws and regulation that the government officers must investigate to define the analysis result of this process.

4) The government authorities conclude and inform the consideration result of land use designations and issue the investigation certificate to the clients.

However, this work is burdensome for the government authorities particularly in the high level of growth rate areas which have abundant client's requests

and the clients also take a long time in order to continue their business. In addition, some government authorities do not have the officers who have enough expertise and comprehend in legislation for the considered building and area information. In case of the officers do not consider all associated regulations or conditions such as width of road in front of the proposed construction area or restricted areas, it will also lead to incorrect analysis results of land use and construction approval. Consequently, the owners of building and land will be affected by such mistakes.

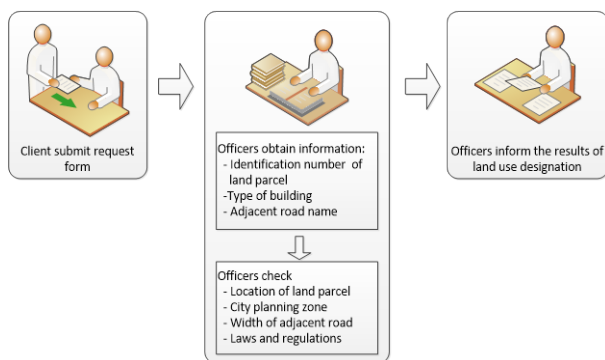


Figure 1. Procedure of land use designation checking

Nowadays, there are several implementations of information technology to assist the construction management including the examination of land use designation and role of expert system and geographic information system (GIS) significantly increases in the previous research. Expert system was applied in many study aspects such as land cover classifying [1-2] and land use planning [3-5]. In order to study the conversion from rural to urban of the city, data and information of land cover obtained from remote sensing technology was analyzed using expert system techniques for classification of land cover types. This technique was developed in one urban area (Phoenix) and then applied to another area (New Delhi). For land use planning, the expert system was developed to provide the customized expert advice of selecting land use practices and crops pertain to the considered agricultural area [3]. It also used for developing a hierarchical rule-based land use extraction for scrutinizing the structures and patterns of residential and commercial land use. However, it had to combine data and information from other technologies such as remote sensing imagery and geographic information system to achieve the efficient results [4-5].

As mentioned above, geographic information system similarly played important roles for construction industry. The applications of geographic information system in the previous research are as follows. Geographic information system was applied for developing a database in order to control the

construction project development. This system was used by the local government authorities for building control permission. The study area of proposed GIS database is in Malaysia and the attribute data consists of land parcel, building information, the existing land development, planning information and development plans, utilities data, community facilities, transportation, environment and the socio-economy. However, the results of this study indicated that in order to implement this proposed system to the local government authorities they required the knowledge transferring process and the attitudes of them related to new technology must be changed. Additionally, this developed database which can be used by many involved parties as a reference point can provide the efficient and transparent service to the public [6]. Another study implemented geographic information system for analyzing and determining type of factory in the industrial estate. This research purposed the initial guideline for establishment of industrial estate. The considered factors including physical conditions, environmental potential, and economic potential was defined and data analysis was applied by using GIS process and Arc View [7].

Geographic information system can be used as tools for developing the approach for evaluating the evolution of coastal area in Canada before and during the implementation of laws and regulations associated with zoning designation. Changes in environmental aspects and georisks of this coastal area were analyzed using aerial photograph and geographic information system technology. The results of this study presented that there were obviously changes in land utilization of this area. The purposes to use land changes from fishery-based economy to tourism and the impact of transformation in human activities leads to increasing environment problems and risk of building along the coastal zone [8].

According to the advantages of expert system and geographical information system, this research aims to develop the prototype expert system incorporating with GIS to support the local government authorities and land owners for checking the land uses designations before submitting construction document to get building control permit. Type of building which clients intend to construct must be examined and demonstrated the land use analysis result. Moreover, laws and regulations which must be concerned and enforced in the prototype area are considered and provided to users of this proposed system.

## 2 Study Area and Related Laws and Regulations

### 2.1 Study area

This research selected Pattaya City in Chonburi

Province, Thailand as a tested area because it is the one of the most famous cities which has a high level of growth rate of land development. This area is a self-governing municipal area which locates in the east coast of the Gulf of Thailand. Total area of the city is 22.2 sq.km. This city is well-known as one of the biggest leisure and entertainment areas and there are plenty attractions both nature and nightlife. In addition, there are satisfactory utilities and convenient transportation. The registered inhabitants are 113,083 people but the non-registered residents are approximately 500,000 including the long-term expatriate visitors. Furthermore, the number of population trends upward every year. As mentioned reason, the demand of residential and commercial building numerously rises and leads to the increasing of building control permission. Presently, the numbers of construction project which submit their document to receive the building control license from local authorities are approximately 400 – 500 projects per year. The tested area was divided into three following subareas for selecting the sample land parcels which are 1) the typical area 2) the area along coastal and 3) the area located in the restricted area and near the beach. All of three subareas are shown in Figure 2 to Figure 4.

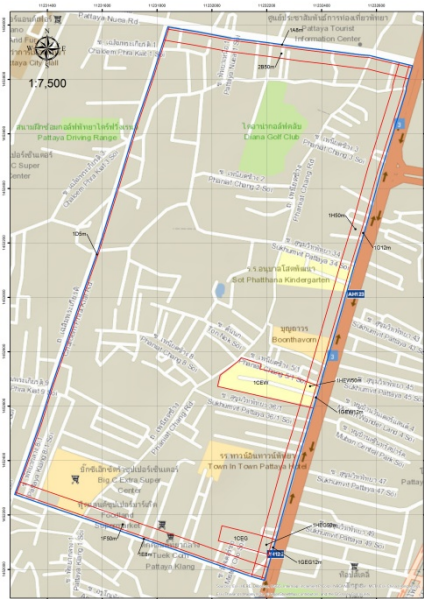


Figure 2. The typical area

## 2.2 Related Laws and Regulations

To develop the prototype system for investigating the land use designation, associated laws and regulations are required and considered. There are four major laws and regulations which normally uses in this tested area. They consist of building control act B.E.

2522(1979), Pattaya Principle City Planning, Regulations of Ministry of Environment and Natural Resources, and Agreements of Pattaya City and Royal Aide-de-Camp Department.



Figure 3. The area along coastal



Figure 4. The area located in the restricted area and near the beach

### 3 System Design

The approach to search and examine the land use designation before submitting the document for building control permission traditionally was done by the local authorities. The incorrect results of this work will affect not only the clients but also the affiliation of the officers. To improve the effectiveness and efficiency of this work, the prototype system was proposed. There are many methods to develop the prototype expert system integrated with geographical information for example using the database of ArcGIS, the advantages of this method is ArcGIS is the existing geographical information database of the government authorities in Thailand and the developers can freely design and create services by themselves, however it requires ArcGIS server license which may influence to the existing system operation.

Another interesting method is developing using web mapping technology such as Google Maps which allows the web users to explore geographical data online and produce maps on demand. This web mapping service (WMS) can improve productivity and well support decision making process but there are some limitations of functionality of web mapping such as spatial analysis which requires the development of spatial decision support system (SDSS) [9]. In order to develop the expert system for this prototype system, the main important components which are a knowledge base and an inference engine were originated. The knowledge engineer had to interview the expert government authorities to obtain the information. Next, such information was organized and created the rules in the inference engine for solving the problems. In this research, a classical rule-based structure represented as an 'if-then' structure was applied due to the problems analysis of land use designation can be effortlessly formulated using this structure. Integrating the prominent capabilities of both GIS and expert system, the proposed system can manipulate, analyze, and present the suitability land use analysis. Figure 5 presents the components of this proposed prototype system with the land database acting as web mapping service spatial database. Three main components of the prototype system are knowledge base, land database, and system web server including the graphical user interface (GUI), the web mapping service, and the inference engine. The knowledge base contains the land use rule-based on the knowledge of existing expert regarding city planning and related laws and regulations and the predefined format rules are also stored to comply with the inference engine for providing the analysis results of land use designation. The land database of this system contains land information such as land parcel identification number, shape of land parcel, and location of land parcel. The users can input

their requirement and receive the response via graphical user interface and analysis results were displayed using web mapping service via the web browser.

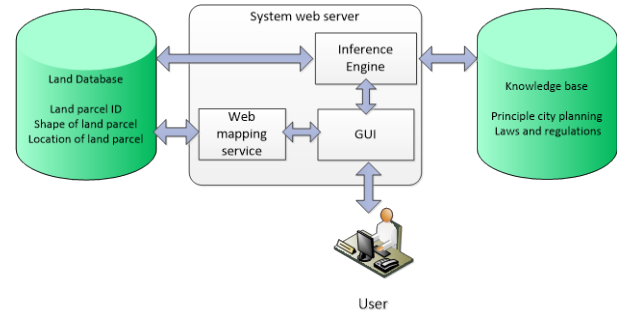


Figure 5. The components of the prototype system

### 4 System Implementation

The implementation of land use designation checking system which integrates the advantages of geographic information system (GIS) and expert system for assisting the government authorities and land owners in Pattaya City is presented in this section. The prototype system graphic user interface is shown in Figure 6. Users can input a land parcel identification number in the input box as presented in number 1 of Figure 6. Then the system will search the location of the land and display its shape and location via web browser application as demonstrated in number 2. The utilization of land and the information such as floor area ratio and open space ratio also presents to give the primary information to the users for example agricultural, commercial, residential, or industrial as portrayed in number 3. In case that users require to check the utilization of land for preparing the building control document, the users must select types of building which are house, row house, apartment, dormitory, hotel, commercial building, department store, or high rise building and also input the width of road in front of the land parcel as shown in number 4. Types of building were predefined in this system. Subsequently, the prototype system will use the rule-based algorithm for investigating that city planning zone of this land parcel, the distance from the adjacent road and from the reference point of mean sea level, and associated laws and regulations. The analysis result of land use designation as users' requirement will be presented as shown in number 5 accompanied with conformed laws and regulation which users must be concerned.

### 5 Conclusion

In order to solving the problems of land use



Figure 6. GUI of the proposed system

investigation which are error-prone of human and time consuming, the proposed system was developed using integration of expert system and geographic information technology (GIS). Web mapping service (WMS) which is Google Maps was applied in this research for manipulating and presenting the geographical data and information. However, the functionality limitation of this application requires supporting engine for the particular land use problems analysis. Thus, the rule-based algorithms were created by obtaining the knowledge and expertise of government authorities from the department of building control. This prototype system can conveniently and efficiently provide the accurate land use information to government authorities, investors, and also inhabitants for performing the building control permission process. In the future research, the information or 3D model of existing buildings on each land parcel should be created and used for new building feasibility study and environmental impact assessment.

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