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WebGIS-based Decision Support System for Estimating the Selling Value of Land Tax Objects in Indonesia

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ABSTRACT

Currently, people get data and information about the Tax Object Selling Value (Nilai Jual Objek Pajak [NJOP]) through their domicile village authority. NJOP is the base for imposition of PBB P2 which is obtained from the average value of the sale transaction conducted fairly. However, if there were no sale or purchase transactions occurred, the price of the object is determined by other alike objects, or new approval values, or NJOP. The problem is that the village party cannot correct the NJOP that have been issued by the Regional Revenue Agency (Badan Pendapatan Daerah) if there is disagreement in the NJOP determination, e.g., the position of an object is closer to the city center but its NJOP is smaller than other objects that are further away. In order to determine a more accurate NJOP, another approach to estimation is needed. The purpose of this study is to develop a decision support system for estimating fairly NJOP. The method used is the combination of the Von Thunen model, the Analytical Hierarchy Process (AHP) and land information overlay based on position selection using four criteria, namely: (1) land use, (2) slope or topography, (3) road function and classification and (4) crowd center or central business district (CBD). The system was developed in a form of a WebGIS application. The result shows that the estimation of NJOP in Bubulak Urban Village area are considered close to the local prices. This system is expected to make it easier for related parties to make decisions, determination, uniformity, justice, and identify various problems regarding land prices in the community, so that they can quickly determine the NJOP more accurately.

Keywords: NJOP, Von Thunen model, AHP, Decision support system, WebGIS application

INTRODUCTION

The government establishes and enforces Land and Building Taxes (PBB) for communities in all regions of Indonesia. The basis used for imposition of Land and Building Tax is the Tax Object Selling Value (NJOP). The NJOP is set every three years by the Mayor or Regent, except in areas where there is a significant development, NJOP is set every year. The high NJOP has often been felt by the community as a form of injustice so that land tax payments become more expensive.

The tax office of Semarang has been determining the NJOP uses the existing pattern and standard with the normative basic factors as well as obstacles that seem cliched. It is caused by the limited number of field appraisal personnel and the mystery of the actual market value happened (the value tends unclear and unpredictable) [1]. With the increase

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in NJOP, the amount of PBB owed will increase so that the level of land tax revenues will increase as well [2].

This study took a case in the area of Bubulak Village, Bogor City, which is located on the border between Bogor City and Bogor Regency. Bubulak has several city transportation terminals, they are the *angkot* terminal, the TransPakuan bus terminal and the Trans-Jakarta (APTB) bus terminal. Bubulak is also the center of crowds in the West Bogor region. The growth rate of rapid development of the city with Bubulak terminals as its center is very high, especially concerning the economy, social and population, causing an increase in the selling price of land in this region. It is proven by the increasing number of shop buildings – so that it can be said as a trading area –, housing, schools, health centers and recreational areas. The land price is very sensitive to changes around it, which is called factors, that can rise or fall [3].

Von Thunen in his theory of distance decay principle was stated that the value of land will be higher if it is closer to the city center [4]. Tax Object Selling Value, hereinafter referred to as NJOP, is the average price obtained from buying and selling transactions that occur naturally, and if there are no buying and selling transactions, NJOP is determined through price comparison with other similar objects, or new acquisition value, or NJOP substitute [5]. Therefore, NJOP determination needs to be dynamic by always adjusting the local selling value. The tax rate is set as follows (Perda No 02 Year, 2012 Article 7): For NJOP up to Rp. 1,000,000,000.00 (one billion rupiah) is set at 0.1% (zero point one percent) per year; For NJOP above Rp. 1,000,000,000.00 (one billion rupiah) is set at 0.2% (zero point two percent) per year.

Land NJOP can be different from the existing market value. This is due to the nature of NJOP which tends to be static because adjustments are not always made, while market values tend to be dynamic following the developments that occur. So that problem arises in the community regarding the low NJOP compared to the increase in land selling price per m^2. This situation raises the idea of creating a space-based system capable of estimating the sale value of land. This WebGIS-based decision support system (DSS) is expected to facilitate the parties involved in making decisions, determining and standardizing land prices, and identifying various issues surrounding higher land prices among the people, so NJOP can balances the actual price of the land. We consider four aspects to estimate land NJOP prices: (1) land use; (2) slope or topography; (3) road function and classification; and (4) CBD.

RESEARCH METHODS

Research Method

The research method used in the development of WebGISbased DSS is shown in Figure 1.

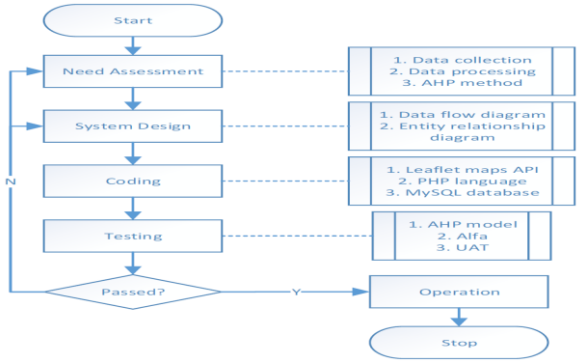

Figure 1. Research Method

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Data Collection

We we conduct interviews and surveys to collect data from the community. The interviews are used to collect data or information from "informants" or "respondents" in a unilateral way, systematic questioning based on the research objectives to be achieved. The communication is carried out through verbal dialogue (question and answer), both directly and indirectly. This interview method is carried out without knowing any variables, i.e., whatever assessment points are intended in estimating the land NJOP. The surveys are used to collect data by observing directly at the location of the study and carrying out systematic records of the phenomena being investigated.

NJOP Estimation Formula

The formula below is used to estimate NJOP. The formula is built based on the result of interviews with experts in the NJOP field.

$$\text{Estimated NJOP} = \left(\frac{K1 * C1 + K2 * C2 + K3 * C3 + K4 * C4}{100}\right) * S$$

with

C1 = weight of land use

C2 = weight of slope/topography

C3 = weight of road function and classification

C4 = weight of CBD

K1 = average value of sub-criteria of land use

K2 = average value of sub-criteria of slope/topography K3 = average value of sub-criteria of road function and

classification

K4 = average value of sub-criteria of CBD

S = Land price based on survey

System Design

The system design uses two modeling approaches, they are: (1) Data Flow Diagram (DFD), used to see flow and process of the data in and out and (2) Entity Relationship Diagram (ERD), used to see relations that can occur between entities in the system. ERD is a technique used to model data requirements of an organization, usually by System Analyst in the requirements analysis phase of a system development project [6].

Coding

The system design is implemented as a web-based application using PHP as its programming language and MySQL as its database server. Leaflet Maps API is used to facilitate PHP for displaying maps on the browser and to perform spatial analysis operation.

Testing

We use three types of testing to ensure that the developed system functions properly and conforms to user requirements specification. Structural testing was performed to ensure that the AHP model built is in accordance with the reality and the assessment of experts. Functional testing was performed to examine the functional of the system. While Alpha testing was carried out by the developer itself, the User Acceptance Test (UAT) was done by involving external parties or potential system users.

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RESULT AND DISCUSSION

System Analysis

The system uses AHP to perform pairwise comparisons among criteria in determining the highest value of each criterion and sub-criteria. This system also uses Von Thunen model approach to identify the price of land based on CBD.

Determination of the value of sub-criteria is obtained from a systematic calculation process in the AHP method. It includes the weighting process on the questionnaire, calculation of priority weight as the giver of priority value and calculation of consistency ratio (CR) as an indicator whether the questionnaire assessment can be accepted or rejected. In the case that the questionnaire assessment is rejected, the process of weighting on the questionnaire must be repeated.

The final process of comparison between the results of expert's interview and the AHP method is carried out by multiplying the weight values matrix of each criterion with the weight values matrix of each sub-criterion where the sub-criteria have the highest priority value.

Business Process Analysis

The system business process is as follows. First, taxpayers fill in their data on the system and input the location of their land using a drag marker, then the data is stored. Admin then verifies taxpayer data from the list of visitors. The system then analyze taxpayer's needs and then inform the result back to taxpayer or store it in the visitor's data directory. The system business process diagram can be seen on Figure 2.

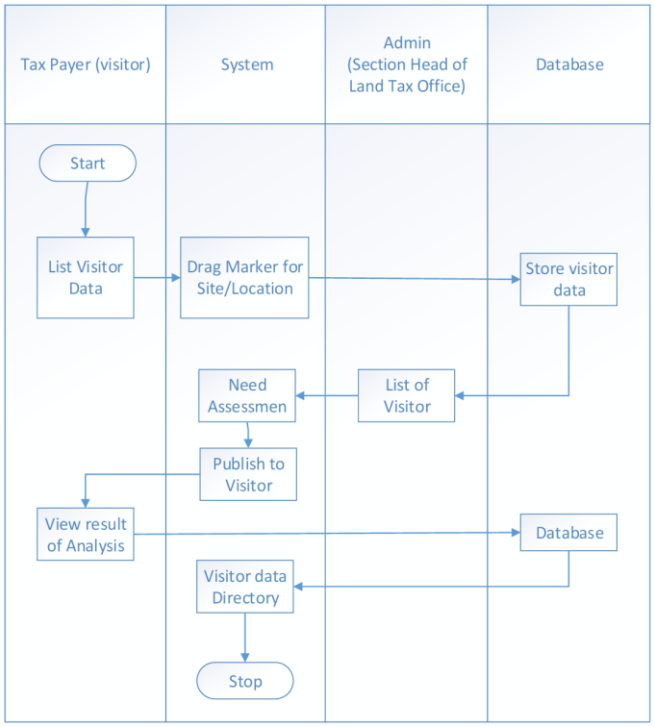

Figure 2. Business Process

List of Actors

The list of actors enumerates all actors who interact in the system. From the context diagram above, it can be identified two actorswho involved in the system as shown in Table 1.

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Tabel 1. *List* of Actor

Actor	Description
Admin (head of regional revenue service, and head of land tax section	An actor who manages the system and provides an assessment of land prices on the system
User (visitor)	An actor who wants to ask for land NJOP on a specific area

Model Analysis

AHP used as a method in comparative analysis of criteria and sub-criteria where the comparison of values produces varying prices. The AHP model is useful for finding priority weight values on the criteria. In the process of working on the AHP model, the steps of the activities carried out are as follows.

Decomposition

The decomposition process was carried out to determine the criteria to be used in estimating land NJOP as well as determine the value and weight of the criteria. 2. Determining Criteria

Based on the results of interviews with experts in the NJOP field, the criteria/sub criteria used in estimating land NJOP were obtained, they are:

a. land use (shopping center, dense settlement, community land, crowd center, ponds, settlement, community settlement)
b. slope or topography: very steep land =>45%, lightly steep land 15-25%, flat land =<8%
c. road function and classification; and
d. central business district (CBD)

Pairwise Comparison

Pairwise comparisons between criteria in the form of a matrix carried out by comparing between the criteria/subcriteria. Values used for comparisons have a scale of 1 to 9 as stated by Saaty [7], after that the sum of per columns is added.

Context Diagram

The context diagram of the system is illustrated in Figure 3. The context diagram describes the relationship between visitors (taxpayers) and Admin (head of land and building tax section) facilitated by the system (DSS). Visitors need to input their private data as well as latitude and longitude position. Admin needs to input criteria and sub criteria as well as analyze data coming from visitors. The system provides services to visitors so they can view visitor lists and NJOP in an area. The system provides services to the Admin so he can see the results of the AHP process.

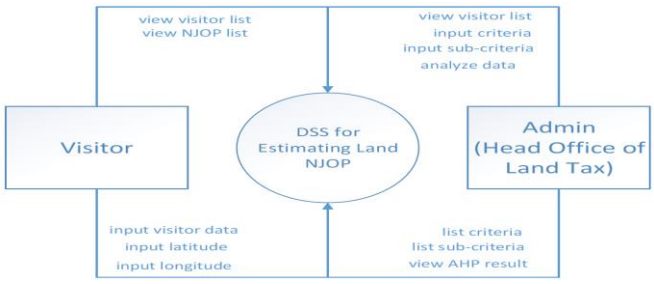

Figure 3. Context Diagram

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F. Entity Relationship Diagram

ERD describes the tables along with their attributes and relations between these tables. The ERD of the system can be seen in Figure 4.

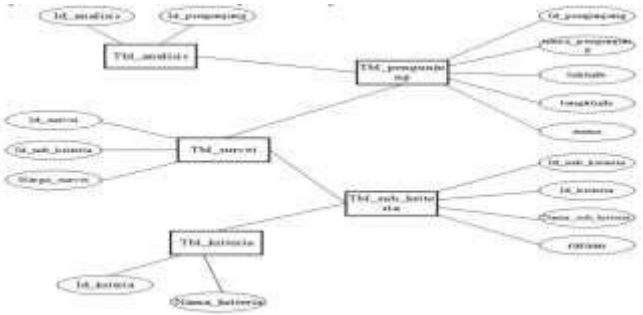

Figure 4. Entity Relationship Diagram (ERD)

G. Database Design

Database design of the system consists of 5 tables as follows:

User table

User table functions to store system user data and its type/level. The user type consists of ADMIN and USER.

Table 2. User

Field	Tipe	Indeks	Deskripsi
id_user	int(2)	*Primary Key*	identitas user
Username	varchar(20)		username akun
password	varchar(15)		password user
Level	varchar(30)		Jenis user

Visitor table

Visitor table used to track visitor who visits the website including his/her position and status. Possible values for land status are SHM, AJB or Girik.

Table 3. Visitor

Field	Type	Index	Description
id_pengunjung	int(4)	*Primary Key*	Visitor identity
nama_pengunjung	varchar(40)		Visitor name
latitude	double(10,6)		Coordinate point
longtitude	double(10,6)		Coordinate point
land_status	varchar(20)		Land status

Criteria table

Criteria table used to store criteria data as shown in Table 4.

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Table 4. Criteria

Field	Type	Index	Description
id_kriteria	int(3)	*Primary Key*	Criteria identity
nama_kriteria	varchar(30)		Criteria name

Sub-Criteria table

Sub criteria table used to store the sub criteria data and average value of each sub criteria as shown in Table 5.

Table 5. Sub-Criteria

Field	Type	Index	Description
id_sub_kriteria	Int(3)	*Primary Key*	Sub-criteria id
id_kriteria	int(3)	*Foreign Key*	Criteria id
nama_sub_kriteria	Varchar (50)		Sub-criteria name
rataan	int(3)		Average value

Analysis table

Table of analysis used to analyze the data from visitor, user and sub criteria to find the result of estimating NJOP as shown in Table 6.

Table 6. Analysis

Field	Type	Index	Description
id_analisis	int(3)	*Primary Key*	Analysis identity
id_pengunjung	int(3)	*Foreign Key*	Visitor identity

Survey Table

Survey table used to store the land price based on the survey as shown in Table 7.

Tabel 7. Survey

Field	Type	Index	Description
id_survei	int(3)	*Primary Key*	Analysis identity
id_sub_kriteria	int(3)	*Foreign Key*	Visitor identity
harga_survei	Int(11)		Land price based on survey

System Implementation

Implementation of the system is based on the results of the design that refers to the analysis of user needs. DSS basically facilitates users who input their land data into the database and Admin who makes criteria / sub criteria.

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Visitors who want to know the NJOP value of their land need to geotagging the location of their land with a drag marker. The system will process the data using the AHP approach and the Von Thunen model which ultimately results in estimating the value of the land.

Figure 6 shows the location of visitors who have dragged the marker. Furthermore, the user data is verified by the Admin and an NJOP estimation analysis is carried out which results are given to visitors. This location can only be seen by the visitors themselves.

Figure 6. User View

Figure 7 shows several locations that can be seen by the Admin after going through a series of verification and analysis of NJOP estimates by the Admin.

Figure 7. Admin View

CONCLUSION

A WebGIS-based DSS for estimating the sales value of land tax objects in Indonesia was successfully developed. The estimation is carried out by comparing 4 criteria:(1) land use (with 7 sub-criteria); (2) slope/topography (with 4 subcriteria); (3) road function and classification (with 4 subcriteria); and (4) CBD (with 5 sub-criteria). The DSS is expected to help the community and related parties in estimating land NJOP more accurately.

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