Model Of Land Acquisition On Toll Road Infrastructure Projects Using Analytical Hierarchy Process And Geographic Information System

Kukuh Widyo Utomo, Budi Susetyo

Abstract: Land acquisition in every construction activity was very important. It usually has been taken a long time and tends to be protracted, it even becomes the main obstacle to job completion. One of the obstacles faced is the difference in land ownership status which requires different handling. This study aimed to create a model by mapping each land ownership status so that the best solution can be found to speed up the land acquisition process. The method used in this research was Analytical Hierarchy Process (AHP) and Geographic Information System (GIS) with the aim (goal) in the form of Land Ownership Status with the highest priority scale, and the criteria used are the inhibiting factors of land acquisition from the results of previous studies. The final result of this research is the ranking order of land ownership status obtained from the calculation of the AHP and land acquisition map in the form of a Geographical Information System that displays the areas to be acquired, with thematic color visualization to distinguish the priority level of Land Ownership Status and monitoring the progress of the area. From the results of this study, it is hoped that the Land Acquisition Committee can be assisted in the land acquisition process so that it can accelerate and takes less time to complete the land acquisition process.

Index Terms: Analytical Hierarchy Process, Geographical Information System, land acquisition, land ownership status, toll road.

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1 INTRODUCTION

SEVERAL phenomena show that infrastructure projects are delayed in completion due to delays in the land acquisition process for the project. This happens because several factors make the land acquisition process difficult to complete. So this is used as the background for this study. Generally, the obstacle faced is land acquisition, which is constrained by ownership. The National Strategic Project in Banten Province is constrained by land acquisition which is located on waqf land, village assets, and agency land [1]. Besides, there are problems with landowners. The problem that often arises is that the landowner does not agree to hand over the land. Areas that experience difficulties in terms of forestry land acquisition, cash land village, waqf land, assets of government agencies and State-Owned Enterprise, locations that become objects in the form of swamps (inundated by water) or peatland, and assets of government agencies controlled or cultivated by third parties (community members) as well as private land on which there is control or cultivation of a third party [2]. Table 1 shows the time settlement required for each Village in the Depok - Antasari Toll Road project, calculated from the date of deliberation to the date of final payment. The urgency of this research is that the Land Acquisition Committee (P2T) is often required to solve various problems in the land acquisition process. A large number of areas with varying problems make P2T difficult to collect the data, analyze problems and determine the solution of each problem, so an analysis system is needed to determine the level of urgency of problems that facilitate P2T to solve land acquisition.

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TABLE 1
TIME OF LAND ACQUISITION

Urban Village	Amount of field	Areas (sq.m)	Time for settlement (days)
Pondok Labu	88	31,677	1,624
Cilandak Barat	562	129,076	2,374
Cilandak Timur	66	22,353	1,792
Ciganjur	78	66,922	1,493
Cipedak	8	2,550	1,472
Pangkalan Jati Baru	437	192,153	2,667
Gandul	124	107,155	1,246
Krukut	813	297,201	2,352

Note. Data obtained from the resumes of researchers from monthly reports in 2020.

The purpose of this study was to formulate the factors that cause delays in the land acquisition process from the results of previous similar research to determine the dominant factors that cause delays in the land process and to control the progress of each field in the form so can speed up the completion of land acquisition. The research starts from the rules and regulations mentioned earlier and through the process of interviews and discussions with experts, the status of land ownership is an important variable in the land process. The status of land ownership in Indonesia is divided into 4 main groups, namely: Waqf land, land owned by residents, government land, and cash village land. The ownership status of the land has different characteristics and ways of handling liberation. This requires a specific and precise method. P2T has difficulty in sorting the weighting rankings of the longest-released land ownership status, both in its progress and the settlement process. The complexity of the land acquisition process requires that decision-makers be able to determine the appropriate action in the application of land acquisition in the field. Analytical Hierarchy Process (AHP) is one of the methods that can be used in this research because it is a method that can organize and analyze complex decisions. T. L. Saaty [3] states that the AHP is a measurement theory through pairwise comparisons and relies on expert judgment to get a priority scale. These scales measure intangible objects in relative terms. Comparisons are made using absolute rating scales which represent, how much more, one element dominates the other concerning a given attribute. N.

326

Widyaningsih, B. P. K. Bintoro, and R. H. Renggah [4] state that the Application of AHP has evolved and is not only used in engineering, management, and business. AHP is also beginning to be recognized by analysts generally giving support to the Government in determining its policies. The AHP design is used to capture the rational perception of human beings that are closely related to a particular problem through a procedure designed to obtain a scale of preference among several alternatives. Besides, AHP is also widely used to obtain a decision from many criteria, resource allocation, priority setting, and planning of strategies that players have in conflict situations [5], [6]. AHP has been integrated with GIS to identify the importance of the criteria used and calculate the weight by using a scale of interest from expert opinion [7], [8], [9].

By using Geographical Information Systems (GIS), data can be displayed in the form of a thematic point area, coupled with graphical and diagramming capabilities which are important tools for data analysis.

GIS is used to study and explore everything about a place. GIS can identify and analyze land features, climate, boundaries, populations, resources, and many other things. Now, GIS can create maps, globe, data, and analytical tools to perform sophisticated analysis, map, store, and share information digitally. GIS can be used to analyze what is happening around a certain area [10]. The effective use of tools and techniques in the preconstruction planning (PCP) stage has a significant effect on project duration, cost, and quality. The use of GIS, as a tool, provides a virtual environment to support various types of geospatial analysis at the PCP stage. Several areas of GIS application in the PCP stage have been identified from existing literature to keep construction professionals informed about the use of GIS in the construction industry [11]. Remote sensing, GIS, and its impact on current land use/land cover are useful in predicting the course of urban growth [12], [13]

2   MATERIAL AND METHODS

Primary data is obtained directly from several sources from various agencies that act as decision-makers on land acquisition projects or also known as experts. The experts are the Engineers (Toll Road Land Acquisition Technical Assistance Consultants) who have carried out daily activities for the implementation of land acquisition. Interviews with experts aim to determine the variables that will be used in AHP, these variables come from previous research which mentions the inhibiting factors of land acquisition. The present from the interview is in the form of determining the criteria and alternatives that will be processed in the calculation process. Meanwhile, secondary data is obtained from detailed map data that has been published by the National Land Agency, Design Map or toll road alignments, and completeness of land parcel data from the survey results of the Land Acquisition Committee. The research design can be seen in Fig.1.
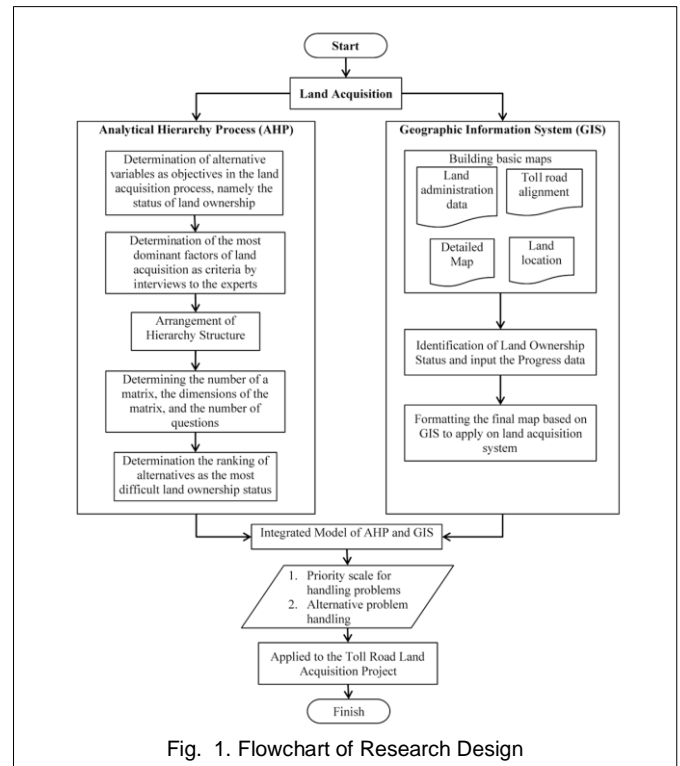

Fig. 1. Flowchart of Research Design

The steps taken in creating a land acquisition system using the AHP method in this study are as follows:
1. Determination of alternative variables as objectives or targets in the land acquisition process, namely the status of land ownership.
2. Identification of Criteria by interview and questionnaires with the experts to determine the most dominant factors in the land acquisition process.
3. Arrangement of Hierarchy Structure.
4. Determining the number of a matrix, the dimensions of the matrix, and the number of questions.
5. Determination of the ranking of alternatives as to the most difficult land ownership status.

The steps to make Maps using GIS are as follows:
1. Building basic maps
2. Identification of Land Ownership Status and input the Progress data
3. Formatting the final map based on GIS to apply to the land acquisition system.

3   RESULT AND DISCUSSION

3.1. DETERMINATION OF ALTERNATIVES AND CRITERIA USING AHP

The goal in this AHP method is determined in the form of Land Ownership Status that takes the longest time to be released. The status of land ownership becomes an alternative by judgment from the expert. It is shown in Table 2 below:

TABLE 2
EXPERT JUDGMENT FOR DETERMINED THE STATUS OF LAND OWNERSHIP AS ALTERNATIVES

No	Alternatives
1	Citizen's land
2	Government's land
3	Waqf land
4	Cash land village

327

The criteria are also determined based on expert judgment and previous research that has been carried out, it is found that the inhibiting factors of the land acquisition process as shown in Table 3.

TABLE 3
PREVIOUS RESEARCH ABOUT THE INHIBITING FACTORS OF LAND ACQUISITION

No	Factors	Previous researches
1	Application Letter for Determination of Development Location (SP2LP); Residual land problems; Late Payment of Compensation	[14]
2	Funds; land data; Human resources; Coordination between residents and the Land; Acquisition Committee; Regulations; Price; Land status; Environment and geography	[15]
3	Amount of compensation; Determination of the amount of compensation by the Land Acquisition Committee which is not independent	[16]
4	Differences in the benchmark value of compensation prices between landowners and the government.	[17]
5	Low public knowledge and awareness of the social functions of land rights; Low public understanding of the importance of toll roads; The price of the compensation amount is too low; Limited investor funds; Land ownership dispute; Difficulty obtaining replacement land for those whose replacement is not using money; Lack of orderly and complete management of land acquisition archives; Insufficient land ownership evidence; Land speculators; Provocateurs; Weak cooperation schemes between the Government and the private sector; A compensation price dispute; Significant differences between land area data and certificates or land ownership documents	[18]
6	Laws and regulations; Procedures for land acquisition and compensation; Land valuation approach to compensation	[19]
7	Inadequate human resources; Implementing officers in the field still have minimum knowledge of applicable policies; Unsustainable in the process of recording and examining land files residents and building residents data due to replacement of officers (employee mutations).	[20]
8	Land dispute	[21]
9	Funding for land acquisition from the State Budget; Collecting land status data and documents; Limited time for National Land Agency	[22]
10	Determination of the price of land to be purchased by agencies requiring land.	[23]

From the primary data, it was found that various factors had to be analyzed for the degree of importance to produce the most important or dominant factors to be used as criteria in AHP. To find the degree of importance of the above factors, the authors make a factor grouping table to facilitate the calculation. Factors that have the same meaning are made into a single criterion with a relevant and close meaning, such as "Amount of compensation" and "Price" are made into "Amount of compensation", or it can also be " Unsustainable in the process of recording and examining land files residents and building residents data due to replacement of officers (employee mutations)" and "Weak cooperation schemes between the Government and the private sector" are made into "Knowledge and coordination of officers".From the results of interviews and judgment by the experts, the factors used as criteria as shown in Table 4 below. A hierarchical structure can be formed after determining the alternative variables and criteria as above. The hierarchical structure that is formed is illustrated in Fig.2 below.

TABLE 4
CRITERIA

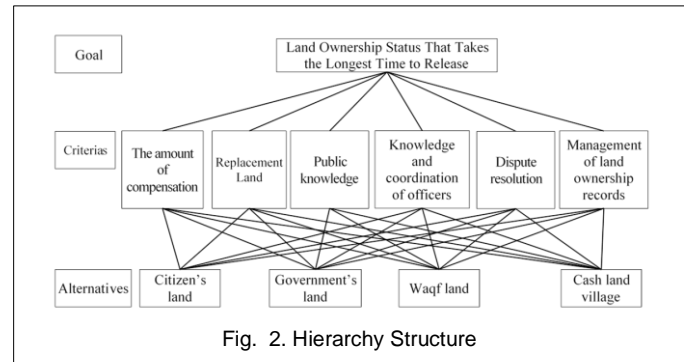| No	Criteria
1	The amount of compensation
2	Replacement Land
3	Public knowledge
4	Knowledge and coordination of officers
5	Dispute resolution
6	Management of land ownership records

Fig. 2. Hierarchy Structure

3.2. EVALUATION OF ALTERNATIVES USING AHP
The comparison matrix for all criteria according to experts can be seen in Table 5. The calculation shows only expert no.1 for example. The eigenvalues calculation of criteria matrix 1 is shown in Table 6 below.

TABLE 5
EXPERT CRITERIA COMPARISON MATRIX 1

Criteria	The amount of compensation	Replacement Land	Public knowledge	Knowledge and coordination of officers	Management of land ownership records	Dispute resolution
The amount of compensation	1	3	5	4	4	4
Replacement Land	1/3	1	4	2	2	4
Public knowledge	1/5	1/4	1	1/3	1/3	1/4
Knowledge and coordination of officers	1/4	1/2	3	1	3	3
Management of land ownership records	1/4	1/2	3	1/3	1	2
Dispute resolution	1/4	1/4	4	1/3	1/2	1

TABLE 6

EIGENVALUES CALCULATION OF CRITERIA MATRIX 1

Criteria	Eigen Value						Total	Average
The amount of compensation	0.44	0.55	0.25	0.50	0.37	0.28	2.38	0.40
Replacement Land	0.15	0.18	0.20	0.25	0.18	0.28	1.24	0.21
Public knowledge	0.09	0.05	0.05	0.04	0.03	0.02	0.27	0.05
Knowledge and coordination of officers	0.11	0.09	0.15	0.13	0.28	0.21	0.96	0.16
Management of land ownership records	0.11	0.09	0.15	0.04	0.09	0.14	0.62	0.10
Dispute resolution	0.11	0.05	0.20	0.04	0.05	0.07	0.51	0.09

TABLE 7
### CALCULATION OF THE GEOMETRIC MEAN OF ALL EXPERTS

Criteria	The amount of compensation	Replacement Land	Public Knowledge	Knowledge and coordination of officers	Management of land ownership records	Dispute resolution	Eigen Value
Alternative	0.29	0.31	0.08	0.14	0.08	0.09	
Cash land village	0.13	0.22	0.11	0.11	0.10	0.13	0.15
Government's land	0.11	0.14	0.09	0.11	0.12	0.13	0.12
Waqf land	0.47	0.32	0.47	0.33	0.33	0.45	0.39
Citizen's land	0.29	0.32	0.33	0.44	0.45	0.29	0.34

Next is to combine the weighting of the combined criteria assessment from all experts with the calculation of the geometric mean which can be seen in Table 7. From Table 7 it can be seen that the eigenvalue (weight) of the alternative land ownership status is the most difficult to acquire. From the table the rank weight order of land ownership status is waqf land, Citizen's land, Cash land village and Government's land.
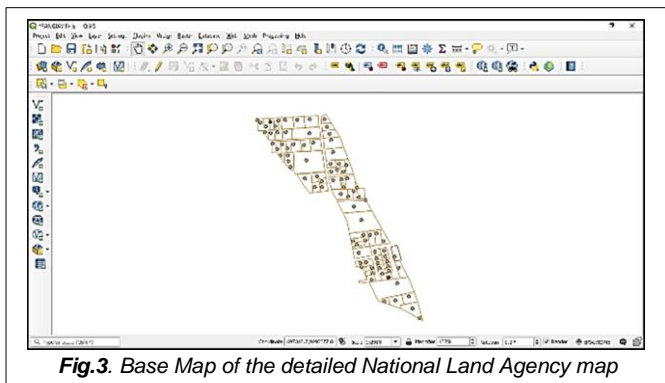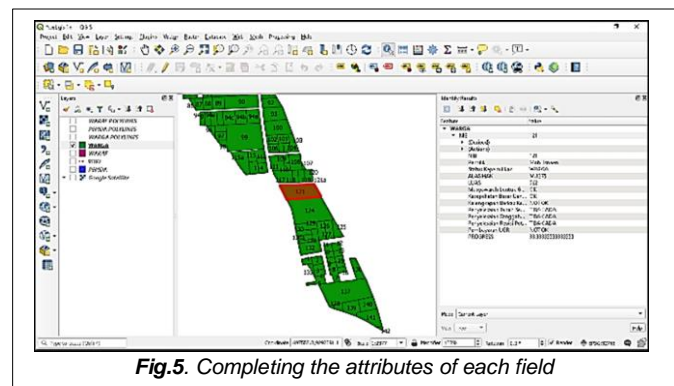
3.3. MAKE A LAND ACQUISITION MAPS USING GIS
A GIS created from the weight order above, The form of a map containing the status of land ownership with different colors to facilitate investigator and monitoring of progress in each area.
The steps for making a GIS for land acquisition can be seen in the pictures below.
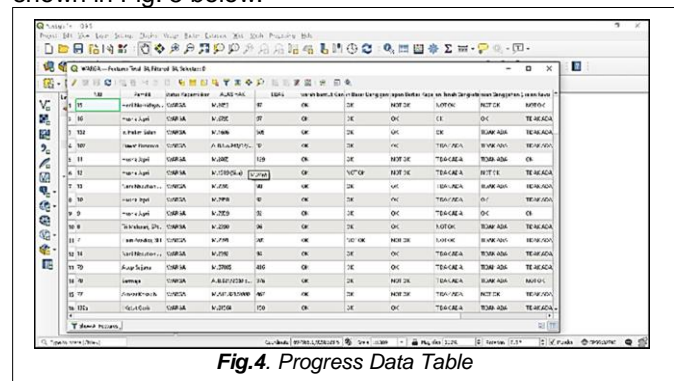
Building Basic Maps
From the detailed map obtained from the National Land Agency, a Base Map is prepared to contain the land situation and the location of the land affected by the project. The base map is a cad file with a .dwg extension, which needs to be converted into a .shp file extension so that it can be processed in Geographic Information System software as shown in Fig. 3.

Fig.3. Base Map of the detailed National Land Agency map

Identification of Land Ownership Status and input the Progress data
Identification of land ownership is obtained from a detailed map of the National Land Agency which contains the Field Identification Number, name of the owner, and ownership status. This form includes a progress data table for procurement activities for each sector as shown in Fig. 4.

The completeness of the attributes applied in the map is shown in Fig. 5 below.

Fig.4. Progress Data Table

Fig.5. Completing the attributes of each field

The formation of the Final map on Land Acquisition is applied to the GIS systemTo facilitate access to this GIS, the system was made in WebGis format which can be accessed anywhere based on the internet. The WebGis display in Fig. 6 below.
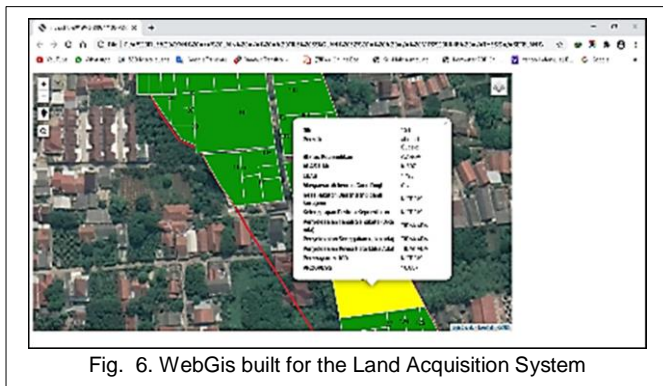
329

Fig. 6. WebGis built for the Land Acquisition System

The implementation of the Land Acquisition model using the AHP and GIS methods after being applied in the field has reaped positive results, namely:

- The results from the model the number of land ownership statuses with each difficulty level can be identified quickly.
- Fields that unresolved and have problems can be more easily detected and logged.
- The distribution of land ownership status is easily identifiable so that the prioritization of areas to be handled can be determined first.

The advantages of this model are as follows:
- The number of experts and their teams can be immediately determined and adjusted according to the case of land ownership status.
- Problem resolution plan can be resolved before the teams going directly to the field
- Supporting the construction preparation process in the form of determining the location of the construction starting point, project mobility, and placement of project support facilities.

4 CONCLUSION

Based on data analysis, result, and discussion, the following research conclusions are obtained:

1. The factors that most inhibiting for the land acquisition process are obtained from previous studies were selected into the 6 most inhibiting factors. With the AHP method, the most inhibiting factor is Replacement Land (31%), The amount of compensation (29%), Knowledge and coordination of officers (14%), Dispute Resolution (9%), Public Knowledge (8%), Management of land ownership records (8%).
2. The objectives in the AHP method are determined in the form of land ownership status that is the most difficult to release. The ranking of criterion weights obtained from the AHP calculation process is Waqf land (39%), Citizen's land (34%), Cash land village (15%), and Government's land (12%).
3. Monitoring of the Land Acquisition System Model using the AHP method and GIS in the form of tables and graphics shown the location and attributes of land ownership status that are the most difficult to acquire. The system makes it easy for the land acquisition committee to identify and anticipate problematic lands.
4. The expected time for completion using this model was under Law of the Republic of Indonesia Number 2 of 2012 concerning Land Acquisition for Development for

Public Interest, 2012 takes 106 days, can be seen in the following description.
- Conference, conducted after the map of the field, owner's name, area, and value of Compensation are published is taken 2 days.
- District Court decisions take 30 days, with details:
  - If rejected and do not submit an appeal, enter into Validation
  - If it is rejected and submits an appeal, it will go to the Supreme Court Decree
  - If accepted and there is no cassation, go to the Change nominative list
  - If accepted and filed for cassation, it will be submitted to the decision of the Supreme Court
- Supreme Court decision takes 44 days
- Consignment Validation takes 3 days
- Validation takes 3 days
- Submission of a Consignment Payment Order Letter and Submission of Payment Order Letter takes 3 days
- Compensation payment 7 days
5. The land acquisition process can be accelerated by forming a team according to land ownership status and problems. The number of experts formed is adjusted to the number of land parcels and their ownership status.

5 ACKNOWLEDGMENT

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