Decision Support System for Proposed Physical Development of Bantul Building Using Case-Based Reasoning

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Abstract. In accordance with Regulation number 1 the year 1994 concerning the general spatial plan, the development must be optimally utilized without ignoring the principle of balance and sustainability. Development programs implemented by the Government of Bantul, specifically the physical construction of the building, or in other words the infrastructure is currently progressing incredibly fast. It is marked with the number of facilities and public services buildings in the Bantul such as government buildings, educational and health facilities, etc. The process of physical building assessment submitted by the regional work units (Satuan Kerja Perangkat Daerah/SKPD). It requires good planning since it involves massive costs and also complies with general spatial planning of Bantul. This research aimed to establish a system of decision making to assess a proposal of the physical development building by using case-based reasoning (CBR). The assessment process is done by entering values on the elements of assessment and also to determine the priority rating for each type of building. The algorithm used is k-Nearest Neighbor with a similarity function by using the Normalized Euclidean Distance. The results show that recommendations follow-on from physical development proposal assessment decision depends on the recommendation of previous cases buildings that ranked first in a list of cases with the results of its smallest Euclidean. Leaders as decision-makers can make decisions by following recommendations issued by the system, but leaders can also determine the outcome of their decisions without following system recommendations.

1. Introduction

In accordance with Regional regulation number 1, 1994 concerning the general spatial planning (Rencana Umum Tata Ruang/RUTR) of the Level II Bantul (for the rest of the paper defines as Bantul), the development of Bantul must utilize the space optimally as reflected in the determination of the level of service functions of activities and network systems. The RUTR also formulated that the use of spatial planning must be based on balance and harmony, namely creating a balance and harmony in the function and intensity of spatial use in one region. In addition to the principle of sustainability, which must also be considered is creating a harmonious relationship between humans and the environment, which is reflected in the pattern and intensity of spatial use.

The RUTR aims to direct the determination of the investments’ location carried out by the government and the community in the Bantul and compile the details of spatial plans in the regions and the development implementation in the use of space for development activities.
The development program carried out by Bantul, in particular, the physical construction of buildings, and are currently progressed very fast. This was marked by many constructions of facilities and infrastructures in Bantul areas such as government buildings, schools, health, and public buildings.

The process of determining the physical development program submitted by the regional work unit (Satuan Kerja Perangkat Daerah/SKPD) under the government of Bantul is not an easy matter since it involves financial issues and must also be in accordance with the RUTR of Bantul. This process requires thorough planning so that the results worth accounted for. The physical construction of the building can be in the form of the construction of a current building and the renovation of a previous building depends on the existing conditions and must also be in accordance with the needs of the community.

The decision-making system using the case-based reasoning method is one of the ways that can be used to evaluate the proposal for the proposed physical construction of the building. By using this decision support system, the government is able to assess whether the physical construction of a building is feasible to be carried out in a certain area or not. This can be seen from several indicators, such as population, the distance of the nearest buildings, community needs and of course the budgets.

2. Method

Case-based reasoning (CBR) is a problem-solving technique that adopts solutions to previous problems that are similar to the current problems faced to get a solution [1]. Cases in the past are stored by including features that describe the characteristics of the case and the solution.

CBR has been widely used in various fields. In general, CBR applications are grouped into classification and synthesis groups, respectively [2] In classifications, each case is grouped according to the similarity that had been seen from its features. The current case then adopts a solution to cases in the same case group. Meanwhile, in the synthesis group, a solution is obtained by combining solutions from previous cases. This group is usually a joint system between CBR and other techniques.

In Figure 1 [3] is explaining about the stages of the system process using CBR, namely that current cases are matched with cases in the database of case storage, and find one or more similar cases (retrieve). The recommended solutions through matching cases are then reused. The solutions offered may be changed and adopted (revise) and if this current case is not suitable in the case storage database, the case-based system then store the current case (retain) in the knowledge database.

![Cycle of CBR](image)

In building a CBR system, the longest effort is to collect cases that then be stored in the case base. If there are difficulties in collecting such cases, the CBR system then is difficult to implement [4].
the case collection process, the role of experts is very necessary, since expert notices more about the problems and the offered solutions for the case.

2.1. Block Diagram of Decision Making System

The block diagram illustrates in Figure 2 is a conceptual description of the system. The block diagram is made based on the CBR architecture cycle, which is retrieval, reuse, revise and retain, respectively, followed by some adjustments based on the system to be developed. Users, in this case, the decision-making officials create a current target case or case, that is by entering the attribute values of the physical construction of an existing building.

![Block Diagram of Decision Making System](image)

Figure 2. Block diagram of a support system decision of proposal evaluation

2.2. Case configuration

Parameters of cases that then included in the case-base is the physical development proposal evaluation criteria of buildings consisting of several elements such are: population, location, distance of similar buildings, the proposed budget, accessible budget, land area and conditions, population needs, availability of implementing staff, electric utilities and water facilities and last but not least, transportation facilities.

The retrieval method used in this study is the nearest neighbor. This method is used by comparing each target case attribute with the source case attributes in the base case. Then the comparison is calculated using the similarity function, namely with normalized Euclidean distance. If the source case value is compared to or equal to the target value, then the solution of the source case is recommended to be the solution to the target case. The following are similarity functions by using normalized Euclidean distance from two vectors $u$ and $v$ [2].

$$
\tilde{d} = (u, v) = \left( \sum_i (\frac{u_i}{\|u\|} - \frac{v_i}{\|v\|})^2 \right)^{1/2}
$$

with

$$
\bar{u}_i = \frac{u_i}{\|u\|}, \quad \bar{v}_i = \frac{v_i}{\|v\|}
$$

$\|v\|$ is norm of $v$ stated as:

$$
\|v\| = \left[ \sum_i v_i^2 \right]^{1/2}
$$

(1)

(2)

(3)
The smaller the score $d = (u, v)$, the more similar the two feature vectors matched. Conversely, the greater the score $d = (u, v)$, the more different the feature vectors are. The properties of the normalized Euclidean distance are the results in the range $0 \ll (d(u, v)) \ll 2$.

Based on the formula above, the process of evaluating the proposed physical development is done by calculating the distance from the current case to the data that has been stored in the case base. For the future development of the system, the number of elements of the assessment may experience changes both increasing and decreasing, according to the needs of the Bappeda Office. Bappeda is the regional development agency, in this case, the Bappeda of Bantul.

Then the system is compared to the current cases with the source case or cases in the case base using the similarity function, in this case, using the normalized Euclidean distance formula. The comparison process has produced a value that is able to determine whether there are similarities or not, between the target case and the source case.

If there are similarities, the solution of the source case then recommended being used by the user. Case revisions are carried out if there is no similarity between the target case and the source case after confirming by the decision-making officials or interested parties. After the decision maker confirms the revised case, the case is then saved into a case base as current knowledge.

2.3. Data Flow Diagram (DFD) Designing

DFD is a diagram used to describe the processes that occur in the developed system and the data involved in each process is able to be defined in [5]. Context diagram of the system for evaluating the proposed physical construction of buildings is illustrated in Figure 3.

Figure 3. Context diagram of DFD level 0

Figure 3 is a diagram that describes the overall system. The diagram involves two elements, namely structural officials and leaders. Structural officials are those who act as evaluators of proposals for building physical construction. Structural officials are the head of physical and infrastructure at the Bappeda office. While the leader is the chairperson or deputy chairperson of the Bappeda.

The next stage, the context diagram then break-down into several subsystems, namely the data recording, the proposal recording, and the decision determination subsystems, respectively. As shown in Figure 4, solving a context diagram is producing DFD level 1.

Structural officials enter data on SKPD, such entered data are, building type, elemental assessment, and assessment data, respectively, on proposals for proposed building physical construction (process 1 and 2). The process of recording data in process 1 and 2 can also be carried out by the leadership, similar as the structural officials do. In addition, leaders also provide input in the form of priority weight values and determine the results of the assessment.

From the entered data, then it is processed and stored. SKPD data is stored in the SKPD table, building type data is stored in the building table, assessment data is stored in the assessment element table, priority weight value data is stored in the assessment table and proposal assessment data is stored in the proposal table, respectively. The next process is the process of determining results. This process can only be done by the head/chairman of Bappeda and structural officials do not have that right. Structural officials only accept the results of recommendations from the system (Figure 5).
The next process is the inclusion of proposal assessment data as shown in Figure 6. In DFD level 2 proposal evaluation, the assessment process is carried out by structural officials or leaders. To enter the proposal assessment data, SKPD data is proposed, followed by the proposed building type data, the elemental assessment data and also the building priority value data of the building. The results of entering the proposal assessment data are then processed to compare the currently entered values with data from the case base based on the same building type. From the comparison results, the system will display the entire list of cases based on the same type of building in the case.
base. The list of cases is displayed based on the ranking of cases which have the smallest Euclidean value to be ranked first.

Based on the list of cases that displayed from the case base, the system recommendations then are issued based on the ranking of the cases. If a case that has the first rank has the recommendation result received, the system then also issues the same recommendation. Likewise, if the previous case has the results rejected, the system is also issued a recommendation rejected. The results of the next proposal evaluation are stored in the proposal table and table of proposal details.

Figure 6. DFD level 2, evaluation process

The next stage of the proposed assessment process is to determine the decisions made by the leadership as decision-makers, can be seen in Figure 7. Before a decision is taken by the leader, first a selection of proposals is made. Then the selected proposal is made a similarity check.

To check similarity, data is needed from the proposal table and the detailed proposal table. After the leader gets the proposal assessment data, Euclidean value data and recommendation data from the system, the leader can determine the decision whether the proposal for the proposed physical building construction submitted by SKPD is acceptable or not. The results of the decisions that have been determined by the leadership, will then be saved back in the proposal table.

Figure 7. DFD level 2, the determination process of development proposal assessment

2.4. Database design and entity relationship diagram

The main purpose of making Entity Relationship Diagrams (ERD) is to display data objects and their relationships [7]. ERD is a model to explain the relationship between data in a database. Before describing the ERD of a system it is necessary to refer to the drawing process through the business rules of the system being built. The business rules of the system for evaluating the proposed physical construction of buildings. This system is designed so that it can be used continuously so that if there is a change in leadership or structural officials, this system can continue to be used.
The entire logical structure of database tables can be graphically illustrated with ERD using the basic components of the ERD. The ERD of the system for evaluating the proposed physical construction of buildings is shown in Figure 8.

![Figure 8. Entity relationship diagram](image)

In general, the application of a system for evaluating the proposed physical construction of buildings designed in this study is desktop based. The application is designed using Microsoft Visual Basic 6 and Microsoft Access programming languages to design the database.

3. Results and Discussion

3.1. Case Base Filling Process

The initial stage of using the system is to enter data that is used as a reference source. Since this system uses the case-based reasoning method, the comparative data must be entered first.

The values included in the assessment of proposals for the proposed physical construction of this building have a range of 0-100. Whereas for building priority weights have a range of 0-10. Entering the database case starts with entering the proposal number, year, SKPD data, building type data, and desired recommendations. After the data is entered in the database, then is to make an assessment of the currently saved proposal.

After the case entry process has been completed, the data case is stored in the proposal's detailed table and proposal table. The data used as a data case is the assessment of the proposed development proposal that was first entered. For the process of entering the assessment data, the first is not compared to any data because it is still current data.

3.2. Result Determination Process

The stage of determining the outcome of a decision is a follow-up process after the completion of the assessment of the proposal for the construction to be completed. The stage of determining the outcome of a decision can only be done by the leader.

In making decisions there are two important components that must be considered by the leadership as decision makers. These components, such as the results of the Euclidean value process and the recommendations issued by the system.

The list of displayed cases is indexed based on the smallest to largest Euclidean value. Cases that have the smallest value is ranked first, and so on. The smallest Euclidean value means that the case has a very similar level of similarity and vice versa.

The recommendations generated by the system are taken based on recommendations from the cases that are ranked first which have the smallest Euclidean value. The recommendations generated by the system are not tied to the Euclidean value produced. While the recommendations displayed by the
system, are the results taken based on recommendations from the most similar cases that are ranked first in the list of cases. If the previous case that is in the first rank has a recommendation accepted then the system will also issue current recommendations received. But if the previous case has a recommendation rejected, then the system will display the same recommendation for the current case.

So, the Euclidean value produced is only used for ranking of previous cases that have the same type of building. While the current recommendations displayed by the system followed the previous recommendations based on the ranking of cases that have the smallest Euclidean value that is ranked first in the list of cases.

After the leader as the decision maker sees the results of the evaluation in the form of Euclidean values and also the recommendations displayed by the system, then for the next stage, the leader can determine the decision. There are two choices given by the system in making decisions, which are accepted or rejected. Since the decision-making system with this case base is subjective, then in making decisions, the leader has several choices (options) that should be used as references as shown in table 1.

| Options | Euclidean |
|---------|-----------|
|         | H (0 – 1) | L (>1) |
| Recommends | accepted | rejected |
| rejected | accepted | rejected |
| N/A | accepted | rejected |

From table 1 it can be explained that the leader can see if the recommendations issued by the system are accepted and the results of the Euclidean process are of little value, the decisions taken are accepted. If the recommendation of the system is rejected, but the results of the Euclidean value process are of little value then the leader should be in making decisions accepted. If the results of the Euclidean value process are small but the recommendations issued by the system are not yet available, then the leader can take the results of the Euclidean value process as a reference, so that the decisions taken are accepted. If the leader sees the results of the Euclidean process are of great value but the recommendations issued by the system are accepted, then the leadership should take the decision to be rejected, bearing in mind that a large Euclidean value indicates that current cases and previous cases have little similarity. If the results of the Euclidean process are of great value and the system for issuing recommendations is rejected, then the leadership should also make a decision to be rejected. If the results of the Euclidean process are of great value and the recommendations of the system are not yet available, then the decision taken is rejected.

Then in the display approval, the proposal is a detailed assessment of the case to be taken. In the details of the assessment, it is seen the values have been filled in the proposed assessment process.

3.3. Case Revision Process

Case revisions in this decision support system are carried out by leaders as decision makers as well as by structural officials. Revisions made by the leadership can be in the form of revisions to previous cases or the current ones. Revisions to previous cases can be done by changing the assessment that is in the element of assessment and priority value. This can also be done by decision makers regarding the assessment of current cases. While the revisions made by structural officials are revisions to add or delete SKPD, building type data and elements of assessment data, respectively.

3.4. Results of the Assessment Calculation Process

The test results of this system are done by comparing the results of the process manually with the process results produced by the decision-making system.

The process of calculating the assessment for each element of assessment is done by multiplying the value on the element of assessment with the priority weight value. For example, the number 588 is generated from the multiplication of number 84 from the rating element and number 7 from the
priority weight value (table 2). Furthermore, similarity checks are carried out with the data in the case base using the normalized Euclidean distance. Calculations to test the results of finding similarities can be seen as following

Vector \( u = [588,536,783,396,156,158,300,336,312,66,112] \)
Vector \( v = [441,680,684,108,141,174,375,378,104,54,198] \)

Normalized Euclidean distance of vector u and v:

\[
\|u\| = \left( \sum_i A_i^2 \right)^{1/2} = \left[ 588^2 + 536^2 + 783^2 + 396^2 + 156^2 + 158^2 + 300^2 + 336^2 + 312^2 + 66^2 + 112^2 \right]^{1/2} = \sqrt{1769385} = 1330.182
\]

\[
v = [441^2 + 680^2 + 684^2 + 108^2 + 141^2 + 174^2 + 375^2 + 378^2 + 104 + 54 + 198^2]
\]

\[
\|v\| = \left( \sum_i A_i^2 \right)^{1/2} = \left[ 441^2 + 680^2 + 684^2 + 108^2 + 141^2 + 174^2 + 375^2 + 378^2 + 104 + 54 + 198^2 \right]^{1/2} = \sqrt{140625 + 142884 + 10816 + 2916 + 39204} = 1234.10
\]

From the results of the tests done manually, the results of the calculation of Euclidean values are 0.33527, which means that the previous and current cases have similarities.

4. Conclusion

CBR is a process of reasoning for a case by using a similar previous case as a comparison. In the decision-making system using the CBR method with the k-nearest neighbour algorithm, similarity data of current cases can be sought with the previous case data. The Euclidean value is only to show the
degree of similarity between the previous case and the current case obtained is not the result of a decision but. The recommendation for the decision on the assessment of the building's physical development proposal depends on the recommendation of the previous case which is ranked first in the list of cases with the smallest Euclidean value. Leaders as decision-makers can make decisions by following recommendations issued by the system, but leaders can also determine the outcome of their decisions without following system recommendations. Decision support system evaluating the proposed physical construction of this building can be used as a means to assist decision makers, in this case, the Chairperson of the Bantul Bappeda in deciding whether to accept or reject the proposed physical construction of the building submitted by the SKPD.

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