Decision Support System for Determining Textile Industry Waste Water Treatment Institution in Web Based Citarum River

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Article Info	Abstract
	The Citarum River is the longest river in West Java. The river participates in the development of the Indonesian economy by 20% of GDP (Gross Domestic Product). In 2018, the citarum river ecosystem structuring survey team found 31 factories in the Bandung Regency region that dumped the waste produced directly into the Citarum River, one of which was the textile industry. In the production process the textile industry uses textile dyes containing azo dyes. The compound has the potential to produce aminobenzen or aniline which causes pollution. The lack of a communal Waste Water Treatment Plant (IPAL) and improper location is a factor that causes the industry to dispose of production waste water directly into the Citarum River. This study aims to support government activities in improving the Citarum River by designing a Decision Support System (DSS) using a website-based Analytical Hierarchy Process (AHP) method to determine the right location to build a communal WWTP. .

1. INTRODUCTION

During the period of 2001 - 2014 the land in the Citarum watershed area was narrowed. According to the Head of the West Java Regional Environmental Management Agency (BPLHD) Anang Sudarna, the Citarum River is used by nearly 30 million residents in West Java. Increasing population and industry caused a change in land use by 10.86% of the Citarum river area and Citarum River water to be polluted. In 2018, the citarum river ecosystem structuring survey team found 31 factories in a number of areas in Bandung Regency until Kutawaringin disposed of production waste directly to the children and mothers of the Citarum River. The lack of communal WWTPs and improper locations is a factor that causes these industry players to dispose of production wastewater directly into the Citarum River water (Arif, 2018).

One of the industries that dispose of the production of wastewater directly into the Citarum River is the textile industry. In the process of dyeing and printing the textile industry uses textile dyes, where the most dominant textile coloring agents are azo dyes or azo dyes. If textile wastewater containing azo dyes is biodegradable, the dye will produce aminobenzen or aniline compounds. Aniline can cause damage to organs, severe eye damage, can cause allergic reactions to the skin, and is very toxic to aquatic living things.

Based on the sampling results in Figure 1 in the study of the presence of aniline in the Citarum River, there is a higher total of aniline in the upstream sediment of the Citarum River. This is an indication that various aniline compounds carried by river water flow can be trapped in mud deposits, and anaerobic biodegradation can occur from azo dyes trapped in silt so that various aniline compounds form. Some of the sediment or river mud originates from textile wastewater treatment sludge, where the mud has a high potential of containing azo dyes (Suhendra et al, 2013).

In the communal WWTP development planning process, there are alternative locations with different specifications. Therefore a system is needed to support decision making in the selection of available alternatives. Decision Support System (DSS) is a computer-based information system that can manage data into information to support decision making. The DSS is supported by the Analytical Hierarchy Process (AHP) method. The AHP method has the ability to solve problems examined by multiple objects and multi criteria based on the comparison of preferences of each element in the hierarchy. Users of the system can make choices about pairs of simple comparisons and build all priorities for alternative sequences

This study aims to find a new location proposal and design a DSS to assist the Bandung Regency Environmental Agency for the construction of communal WWTPs in the textile

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industry in the upstream Citarum watershed area. In the process of designing a Decision Support System (DSS) that determines the exact location to build WWTP in the textile industry in the Citarum River basin, this design is carried out by doing 4 phases in the system of decision making. The four phases are, the phase of intelligence, the design phase, the selection phase, and the implementation phase. In the selection phase there is an alternative selection using the Analytical Hierarchy Process (AHP) method.
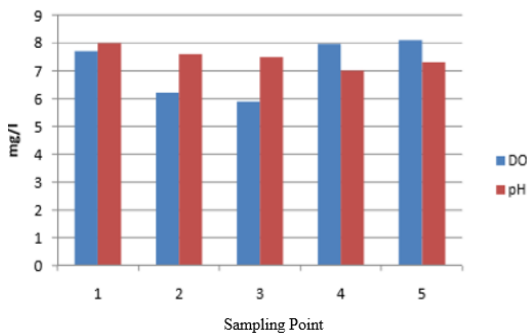

Figure 1.
Results of pH and DO analysis at the end of the Upper Citarum River

2. LITERATUR REVIEW

2.1 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a decision-making tool that describes a complex problem in a hierarchical structure with many levels consisting of goals, criteria, and alternatives. Hierarchy is defined as a representation of a complex problem in a multilevel structure where the first level is a goal, followed by a factor level, criteria, subcriteria, and so on down to the last level of the alternative. With hierarchy, a complex problem can be broken down into groups which are then arranged into a form of hierarchy so that the problem will appear more structured and systematic (Palangda, 2015).

In solving the problem as for the steps in the AHP method that must be done, including:
1. Define the problem and determine the desired solution.
2. Create a hierarchical structure that starts with the main goal.
3. Make a paired comparison matrix
4. Check hierarchy consistency

2.2 Comunal Waste Water Treatment Plant

Waste treatment systems are needed in an industrial area, but given the limited land in a factory, some factories will dispose of production waste into the river. The Waste Water Treatment Plant or commonly called communal WWTP is a centralized wastewater treatment system that is a building that is used to process domestic wastewater

that is communally functioned (used by a group of industries) to be safer when disposed of into the environment, according to the standard environmental quality (Turban et al, 2005)

2.3 Decision Support System (DSS)

A system that has the ability to solve a problem by providing information or a proposed decision is called a Decision Support System (DSS). The initial definition of a Decision Support System (DSS) (Jajac et al, 2019). is a system that supports managerial decision makers in semi-structured decision situations. Decision Support System (DSS) in addition to decision makers to convince in choosing an alternative that exists, but not to replace their judgment.

3. METHODOLOGY

In making a decision support system, it takes a process that must be passed to make a decision. The decision-making process includes four main phases, namely intelligence, design, choice, and implementation. Figure 2 is a systematic in the decision-making process in this study. According to Figure 2, the decision making process in this study consisted of four phases. The following are the phases carried out in this study:

3.1 Intelligence Phase

The first phase in the decision making process is the intelligence phase. The intelligence phase is the phase consisting of activities identifying problem opportunities, determining the problem that is happening, and determining the problem owner of the problem. These activities are carried out by scanning the surrounding environment in an intelligent or directed manner.

This intelligence phase begins with the identification of goals and objectives expected by an organization, the organization will link to the existing issues and ascertain whether these objectives will be met or not. Problems arise because of a sense of dissatisfaction or there is a difference between the results obtained with expected. In this intelligence phase, someone will find out the cause by identifying the symptoms of the problem.

3.2 Design Phase

After identifying and finding a problem in the intelligence phase, the next phase is the design phase. The design phase involves finding or developing and analyzing actions that will be carried out. This includes understanding the problems that occur that will be used as a model. The model will be constructed, tested and validated.

3.3 Choice Phase

The choice phase is the phase in which actual decisions are made and where commitments to follow certain actions are made. The boundary between the design phase and choice is often unclear because certain activities can be carried out during the two phases running and one can often return from the choice phase to the design phase. For example, someone can produce new alternatives while evaluating existing ones. The choice phase includes searching, evaluating, and recommending solutions that are appropriate for the model. The solution to the model is a set of values for the decision variable in the chosen alternative.

3.4 Implementation Phase

The implementation phase is the final phase in the decision making process, but this process requires a long time and is involved with unclear boundaries. In essence the implementation of a proposed solution to a problem is the initiation of new things, or the introduction of changes, which must be managed. Implementation means placing the recommended solution and not necessarily requiring the implementation of a computer system. Many generic implementation problems that arise such as rejection of change, the level of top management support, and user training, are important in handling management support systems. The decision making process can also be improved with the support of computer systems, computer system updates should ideally involve some sort of formal information system development approach.

4. RESULTS AND DISCUSSION

Based on the research method, in this study four phases were planned in planning a decision support system to determine the location of WWTP development. These phases are the intelligence phase, the design phase, the choice phase, and the implementation phase.

4.1 Intelligence Phase Result

Based on preliminary observations it can be seen that the sector that causes the most pollution in the Citarum River is industry. One such industry is industry. The interview with the head of the section on monitoring the quality of the environment, the pollution seen directly on the water surface of the Citarum River is the dye waste produced by the textile industry. In 2010 the number of textile industries that had waste water disposal permits reached 54 companies, but there are still many industries that dispose of production waste directly to Citarum River children and mothers because operational costs are quite expensive.

The lack of procurement of communal WWTPs and improper locations is a factor that causes these industry players to dispose of production wastewater directly into the Citarum River water. Therefore a communal WWTP is needed that can accommodate these industrial wastes.

Based on the existing symptoms, the owner of the problem is the Bandung Regency government and the Regional Environmental Management Agency (BPLHD) who are trying to overcome pollution in the Citarum River. Then the formulation of the problem of this research is the right location to build the right Waste Water Treatment Plant (WWTP) to treat the waste produced by the textile industry. In making decisions on many alternatives and available criteria, a system is needed to support the decision to determine alternative locations.

Intelligence Phase
1. Initial observation
2. Identification of problems
3. Ownership of problems
4. Statement of problem
5. Identify objectives

Design Phase
1. Identify system requirements
2. Identify system inputs and outputs
3. User identification
4. Designing the proposed process
5. Designing system components

Implementation Phase
1. System testing
2. Analysis of the AHP method

Choice phase
1. Selection method
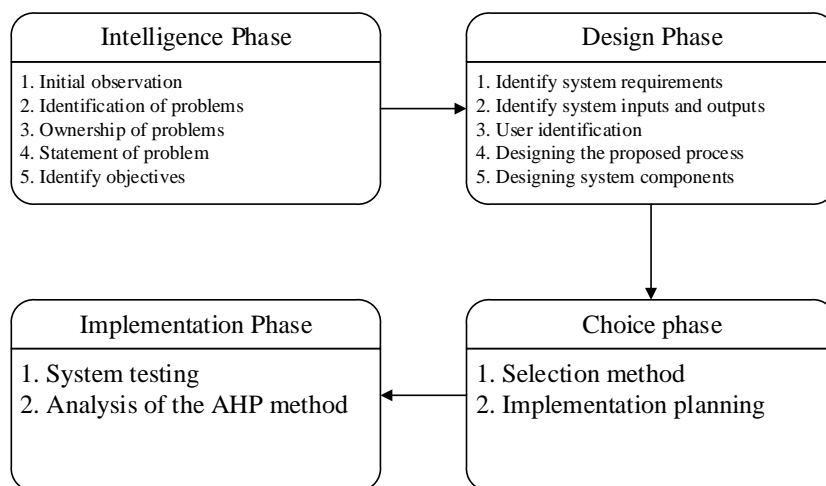2. Implementation planning

Figure 2.
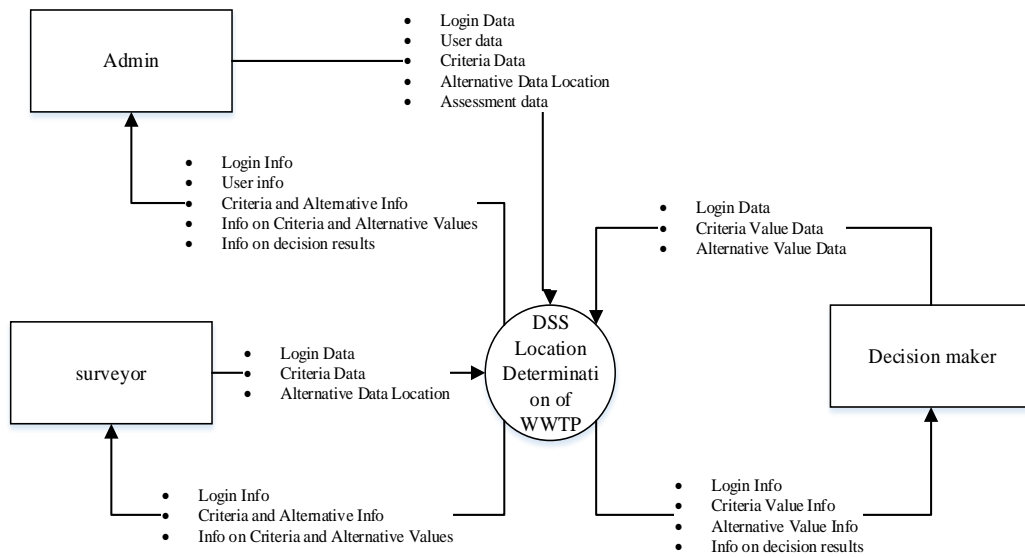User needs and technical requirements

Figure 3.
Context diagram
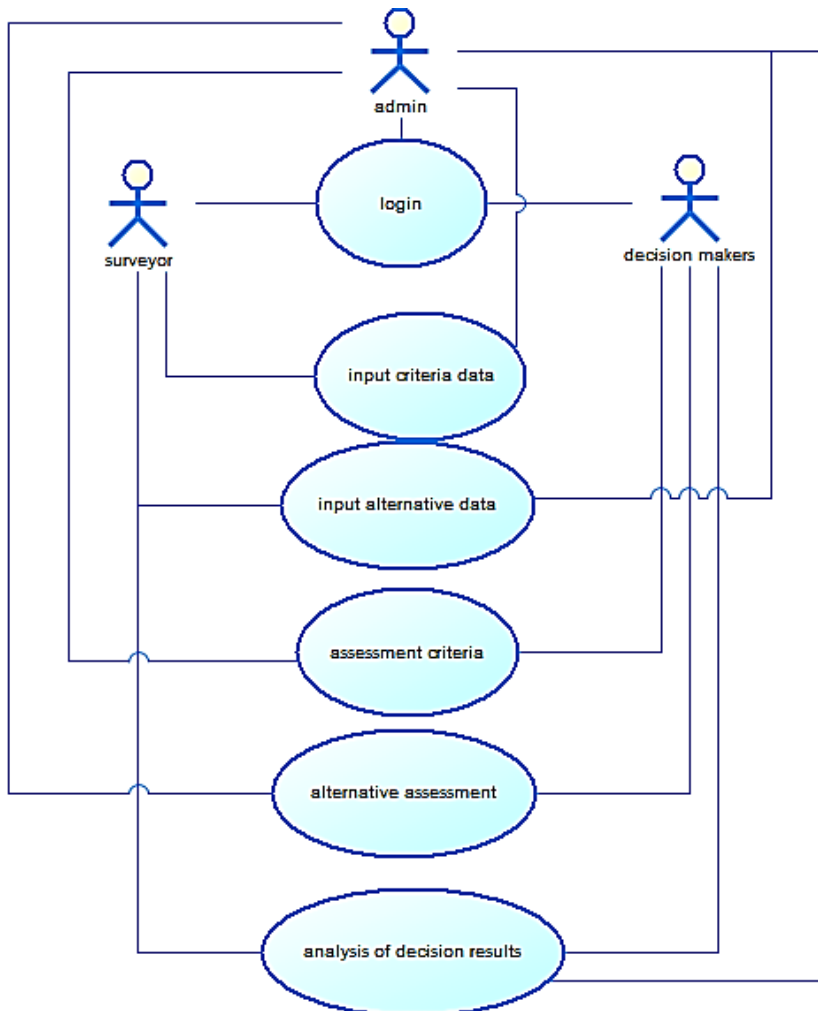
Figure 4.
Usecase diagram

Table 1.
Criteria for the construction of WWTP

Code	Aspect	Criteria	Information
K1	Technology ecological	Constructability	The process of building construction and excavation of buildings.
K2		quality of infrastructure utilities	Satisfaction quality of infrastructure connected to waste water treatment sites (water supply systems, sewage systems, electrical systems, sewage systems)
K3	socio-economic	attraction of location	The attractiveness of the location of the surrounding area that has potential in terms of quality of life and business with the situation in the area
K4	Technology ecological	The sensitivity of the surrounding area to noise pollution and gas emissions	Proximity between residential areas and population density
K5		Frequency of waste transportation	Air pollution and noise generated by waste water transport trucks.

Table 2.
Interest Rates.

| Intensity of Interest	Information
1	Both elements are equally important.
3	One element is a little more important than the other elements
5	One element is more important than the other elements
7	One element is clearly more important than other elements.
9	One element is absolutely important than the other elements.
2,4,6,8	The values between two consideration values are close together
the opposite	If activity i gets one number compared to activity j, then j has the opposite value compared to it.
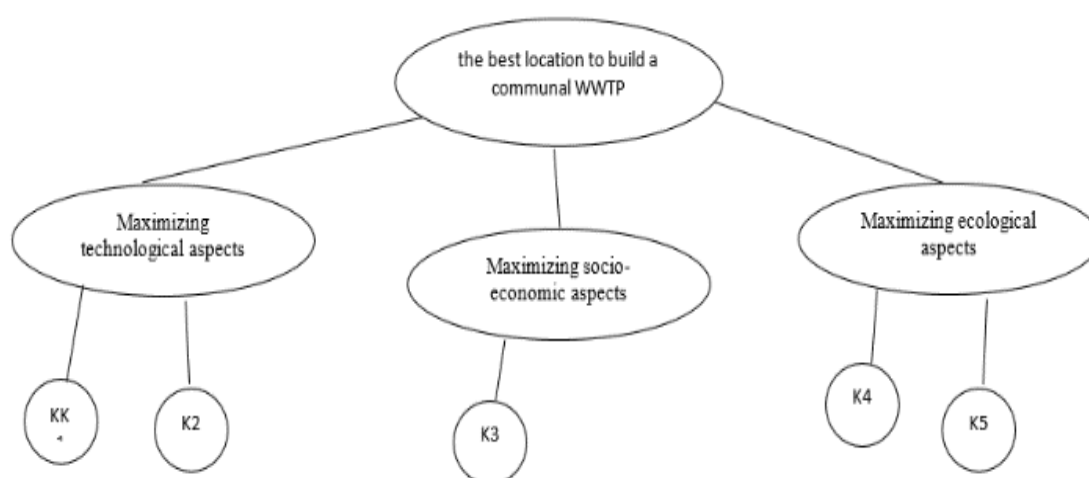
Figure 5.
Purpose hierarchy structure

4.2 Design Phase Result

4.2.1 Context Diagram

The highest level in the data stream is a context diagram. This diagram has only one process that shows the system as a whole. The context diagram describes the relationship of inputs and outputs of the Decision Support System (DSS) to determine the location of WWTPs. The context diagram of this system can be seen in Figure 3.

4.2.2 Usecase Diagram

Usecase diagrams are used to obtain the functional requirements of a system. The components in diagra usecase explain communication between actors and systems. Usecase diagram of this system can be seen in Figure 4.

4.3 Design Phase Result

In the design of the Decision Support System (DSS) the determination of the location of the WWTP is used the Analytical Hierarchy Process (AHP) method to solve the problem of determining the location of the Waste Water Treatment Plant (WWTP) development project. The project manager is the Bandung Regency Environmental Agency (DLH) who is authorized in planning the procurement of WWTPs. In the project there are several choices of alternative development sites in each textile industry cluster, these alternatives will be considered based on the criteria set by the project manager as the decision maker.

After defining the problem, the next step is the formation of a goal hierarchy. In the first hierarchy there is the main objective of this problem, the goal is "to determine the best location to build a communal WWTP". In the second hierarchy there are criteria considered in the IPAL construction project. Based on previous research there are three aspects of the criteria considered in the selection of the construction site of WWTP, these three aspects are technological, socio-economic, and ecological. These aspects have sub-criteria labeled with C_n, where n = 1 - 5. The project manager defines the technological aspects as having sub-criteria K1 and K2, the socio-economic aspects have K3 sub-criteria, and the ecological aspects have sub-criteria. criteria K4 and K5. The definition of the hierarchy of objectives along with the sub-criteria used in the calculation of the DSS for determining the WWTP location can be seen in Figure 5 and an explanation of the criteria can be seen in Table 1.

Based on the objective hierarchy structure, the AHP method is used to determine the importance of sub-criteria in achieving goals. starting from the top of the structure of the objective hierarchy (level of the main objective), through the middle level (objective level), down (level of criteria). The weight of each criterion is expressed by the percentage of the total weight of all criteria, which is 100%. At the criteria level, the project manager can provide perceptual assessments. The assessment process and the comparison between criteria with importance rating scale. The scale of interest according to Saaty (1988) can be seen in Table 2. Criteria that have been compared and assessed are then converted into paired matrices in Table 3 using the intensity scale of AHP interests.

Table 3.
The pairing matrix between criteria

Criteria	K1	K2	K3	K4	K5
K1	1	0,50	3	0,20	0,33
K2	2	1	5	0,25	3
K3	0,33	0,20	1	0,20	0,50
K4	5	4	5	1	4
K5	3	0,33	2	0,25	1
TOTAL	11,33	6,03	16,00	1,90	8,83

After adding the paired matrices to each criterion column that can be seen in table V.3, it is necessary to examine the consistency of the assessment by determining the consistency ratio value (CR). This process is done by changing the paired matrix to the normalization matrix and priority vector of each criterion. The matrix can be seen in Table 4. After establishing criteria for the construction of a Wastewater Development Installation (IPAL), there are alternative locations that will be used for the construction of communal WWTPs in a group or cluster. Alternative locations for construction of WWTP can be seen in Table 5.

Then a process of comparing the alternative location criteria is carried out. Available alternatives are assessed by importance rating scale. Alternatives that have been compared and assessed are then converted into a paired matrix. Then to find out the consistency of the assessment, a consistency ratio (CR) value is needed by normalizing the pairwise comparison matrix. Assessment is said to be consistent if it is worth less than 10% or CR <0.1. The results of the recapitulation of assessments and calculations of inter-alternative comparisons based on all criteria for determining the location of WWTP can be seen in Table 6.

Table 4.
Normalized pairing matrix between criteria

Criteria	K1	K2	K3	K4	K5	Total	*Priority Vector*
K1	0,09	0,08	0,19	0,11	0,04	0,50	0,100
K2	0,18	0,17	0,31	0,13	0,34	1,13	0,225
K3	0,03	0,03	0,06	0,11	0,06	0,29	0,057
K4	0,44	0,66	0,31	0,53	0,45	2,40	0,479
K5	0,26	0,06	0,13	0,13	0,11	0,69	0,138
Total	1,00	1,00	1,00	1,00	1,00	5,00	1,00

Table 5.
Alternative locations for construction of WWTP

No.	Alternative Name	Address
1.	Alternatif - A	Jl. Tarajusari KM.04 No.27, Tarajusari, Banjaran, Bandung, Jawa Barat 40377
2.	Alternatif - B	Jl. Raya banjaran km 18,5, Banjaran, Jawa Barat, Indonesia 40377
3.	Alternatif - C	Jl. Tarajusari No.201, Tarajusari, Banjaran, Bandung, Jawa Barat 40377

Table 6.
Value of all priority criteria and alternative vectors

Priority Vector	K1	K2	K3	K4	K5
	0,10	0,23	0,06	0,48	0,14
A1	0,63	0,10	0,28	0,28	0,35
A2	0,11	0,67	0,10	0,62	0,11
A3	0,26	0,23	0,62	0,10	0,54

In searching for the total ranking for each alternative location to be received is by multiplying the priority vector value of each alternative with the priority vector values of all the criteria in Table 6, namely the results of each priority vector multiplied by the criteria priority vector column. The multiplication method can be seen below:

Manual calculation of total ranking for all criteria:

A1 = (0.10 x 0.63) + (0.23 x 0.10) + (0.06 x 0.28) + (0.48 x 0.28) + (0,14 x 0,35)= 0.29
A2 = (0.10 x 0.11) + (0.23 x 0.67) + (0.06 x 0.10) + (0.48 x 0.62) + (0,14 x 0,11)= 0.48
A3 = (0.10 x 0.26) + (0.23 x 0.23) + (0.06 x 0.62) + (0.48 x 0.10) + (0,14 x 0,54) = 0.23

From the results of the above calculations it is known that the order of Global Priorities from the alternative locations to be built by the Waste Water Treatment Plant (WWTP) are as follows:

1. Alternative B in the first rank with a total value of 0.48
2. Alternative A in the second rank with a total value of 0.29
3. Alternative C in the third rank with a total value of 0.23.

Based on the calculation of manual calculation using the Analytical Hierarchy Process (AHP) method, the alternative location proposed to be the location of the construction of Waste Water Treatment Plant (IPAL) is alternative B because it has the highest priority weight (0.48) compared to alternatives A and C.

4.4 Implementation Phase Result

Following is the website display of Decision Support System (DSS) for determining the location of Waste Water Treatment Plant (WWTP):

- Login page
  The login page is the first display that will appear when a user accesses this DSS. On this page the user will enter an account username and password. If the account entered is in accordance with the account that has been registered in the system database, the system will point to the system's main menu. The implementation of login page interface can be seen in Figure 6.
- Implementation of the User Data Master Interface
  The user data master menu is a feature to find out users who can access the DSS website. The implementation of this website user data master interface can be seen in Figure 7.
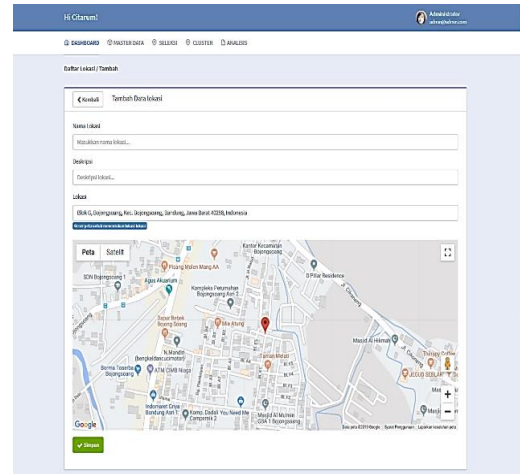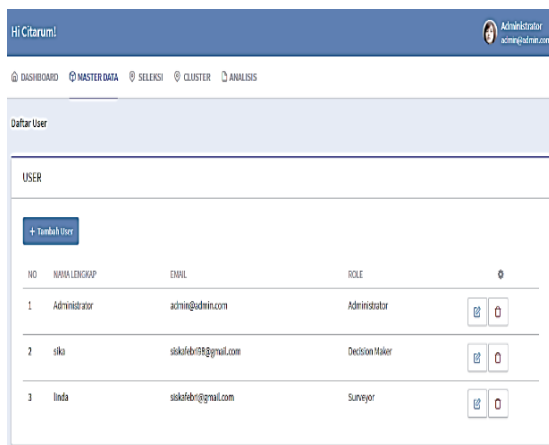
Figure 6.
Login page

Figure 7.
Implementation of the Master Data User Interface.

Figure 8.
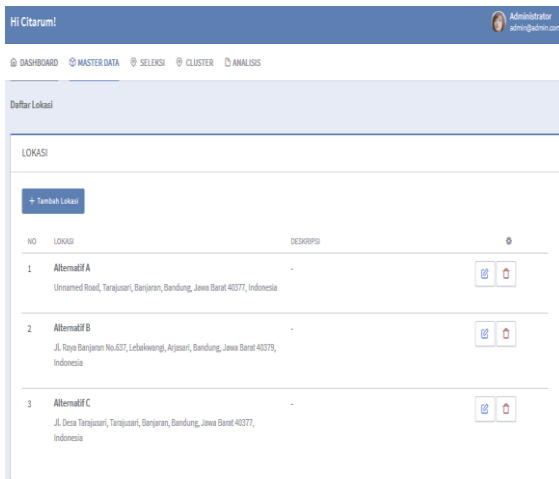Interface Implementation for Location Data Master

Figure 9.
Interface implementation to add location data master

- Implementation of the Location Data Master Interface.
  The master location data is a page of alternative data locations that will be built by the communal WWTP. The implementation of this website location data master interface can be seen in Figure 8 and the location data added feature can be seen in Figure 9.

- Implementation of Master Data Interface Criteria
  The master data criterion is a page of criteria data in the process of determining the location in the project to build a communal WWTP. Implementation of the criteria data master interface of this website can be seen in Figure 10.

- Implementation Interface Analysis of Criteria and Alternative Values
  Criteria value analysis is a page that is used by a decision maker to carry out a comparison of criteria and alternatives. The implementation of the criteria analysis interface on this website can be seen in Figure 11.

- Interface Implementation Results of the decision
  The results of the decision are the final results of the Decision Support System (DSS) website determining the location of the Waste Water Treatment Plant (WWTP). On the results page, information is displayed based on cluster selection. On the page, it can be seen the selection table that displays the recapitulation of the results of the AHP method calculation, the results are also supported by a bar chart that shows the comparison between alternatives based on existing criteria, and supported by digital maps to show the best alternative location coordinates. The implementation of the website's decision-making interface can be seen in Figure 12.
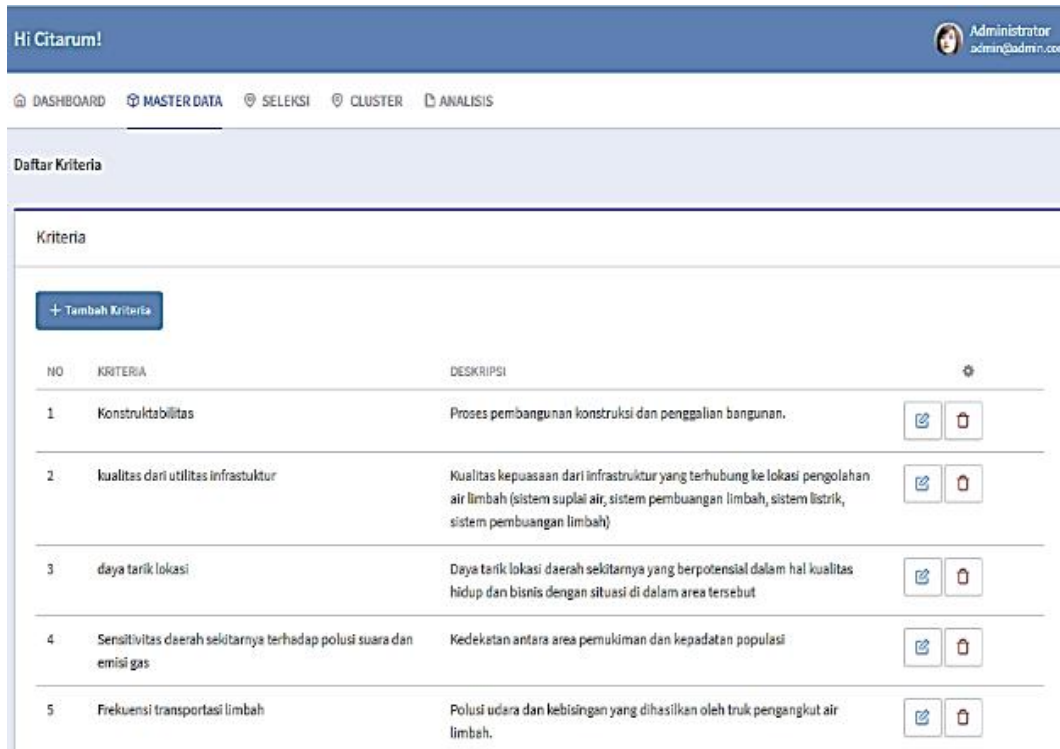
Figure 10.
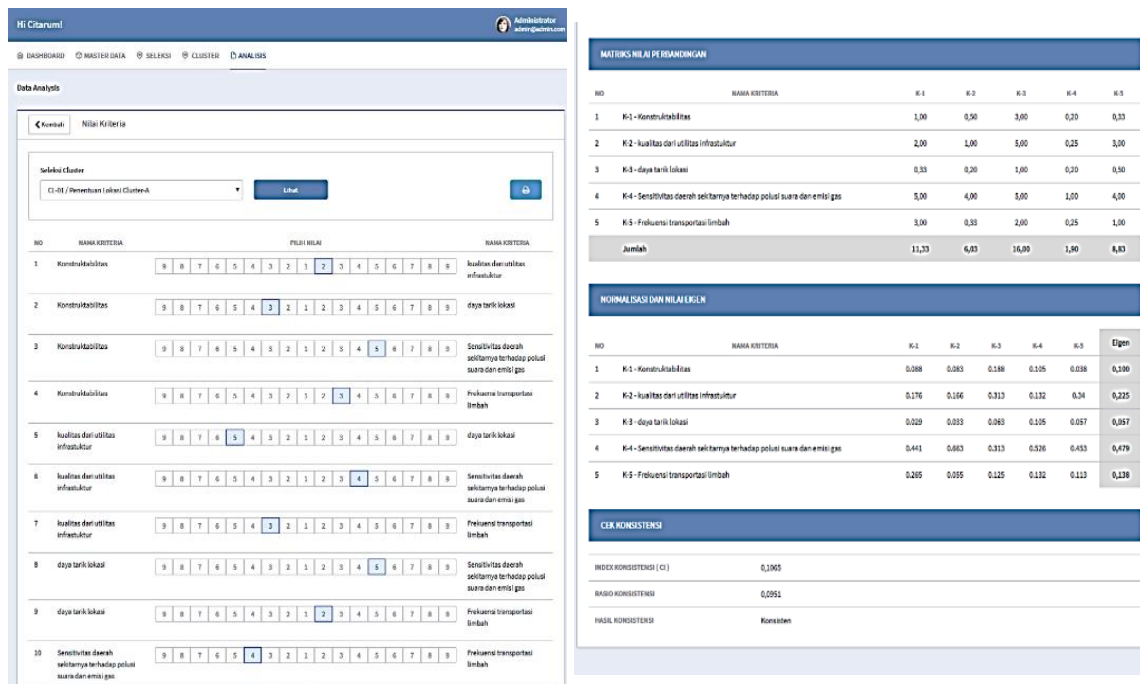Interface Implementation for Data Master Criteria

Figure 11.
Interface Implementation for Analysis of Criteria and Alternative Values

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Figure 12.
Interface Implementation for Decision Results

5. CONCLUSION

The results of the decision-making design process of the Decision Support System (DSS) determining the location of the AHP Waste Water Treatment Plant (IPAL) method by carrying out 4 phases of decision making can be concluded that:

1. The DSS that determines the location of the WWTP can provide convenience to the Environmental Office in making decisions in the communal WWTP development planning process because the DSS website has an easy-to-understand assessment form feature and can reduce errors in giving assessment.

2. The DSS determining location of this WWTP can store a database for determining the location of the previous and future periods. Data related to criteria and alternative locations are also stored in the system database. The database is useful as a reference for evaluating website users as decision makers.

3. The DSS determining the location of this WWTP can accumulate data automatically as desired by the user. Users will get results in the form of a priority development site proposal report.

4. Based on calculations carried out by the system with the AHP method, the proposed location of

the right land to be used as an WWTP is alternative B.

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