The analysis of channel type combination alternative of “Klambu-Kudu” raw water channel

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The analysis of channel type combination alternative of "Klambu-Kudu" raw water channel

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1. Introduction

1.1. Background of the Research

"Klambu Kudu" channel conveys raw water from Intake in "Klambu" Weir, Grobogan District to "Kudu" WTP in *Kelurahan* Kudu, *Kecamatan* Genuk, Semarang City. It is 40,558 km length stretching from East at Grobogan to West at Semarang and passing through 3 (three) districts/cities, that are Grobogan District, Demak District and Semarang City.

Most of "Klambu Kudu" channel are open channel which passes through farming areas so that there is a possibility for the raw water to be 'stolen' for farming during dry season. On the other hand, during rainy season, there is a potential of rain water overflowing "Klambu Kudu" channel which causing high concentration of mud in the standard. Furthermore, the flow rate arrived at "Kudu" WTP can be reduced or even stopped when the channels at some locations are broken or when the raw water flows is obstructed by rubbish. Therefore, the amount of water rate of flow from Intake at "Klambu" Weir to "Kudu" WTP has discrepancies compared to the planned one. This situation raises some questions on the selection of the channel type with consideration on each locale conditions.

1.2. Problem of Research

Alonf the 40,558 km length, "Klambu Kudu" channels is managed into of 7 (seven) working areas called '*kemandoran*'. Each of *Kemandoran* has different channel types which brings its own problems. It is necessary to evaluate the appropriateness on the type of channels's selection. As there are many channel type combinations, a model of Decision Making Supporting System (DSS) is required to help the selection on which alternative on channel type combinations is suitable for "Klambu Kudu".

1.3. Aim of the Research

This research objective is developing a model of Multi Criteria Decision Making System by using AHP model to help the selection of channels types combination at Klambu-Kudu.

1.4. Purpose of the Research

The purpose of this research are as follows:

- Deciding the most influencing factor in selecting the most suitable channel combination type for "Klambu Kudu" system.
- Analizing "Klambu Kudu" alternative channel type combinations which is suitable with the areas it passed through based on the criteria of development implementation cost, operation and maintenance cost, the ease of operation and maintenace implementation as well as benefit/profit.
- Analizing the sensitivity of the criteria of the channel type combination selection.

1.5. Location of the Research

The scope of the research is the location of "Klambu Kudu" system from "Klambu" Weir at Grobogan District to "Kudu" WTP in Semarang City.

2. Literature Study

Turban, et.al., (2001) said that the concept of Decision Supporting System (DSS) is firstly emerge on the early of 1970's by Scott Morton. According to (Turban, et.al., 2005), DSS is an approach to support the decision making. It is one of software products specifically developed to help the management for the decision making process (Nazibu, 2009). The term DSS is made on 1971 by G Anthony Gorry and Michael S. Scott Morton to direct the computer application in managing the decision making (Nazibu, 2009).

A decision making means choosing several available alternative actions to reach one or several decided goals (Turban, et.al., 2005). The act of determining a criterion on a decision making process is one of important factors as the criterion itself shows the problem's definition in a concrete form and sometimes it is considered as the achieved target (Sawicki, 1992 in Marimin, 2004). (Hasan, 2002) stated that, the concept of DSS is marked with a computer based interractive system which help a decision maker to make use of data and model to solve unstructured problem. According to (Sobriyah, 2005), the analysis of DSS is initiated by identifying problem along with determining activity goals and decision support parameter. In (Nazibu, 2009), there are many DSS application. It can be used independently like Expert Choice, Super Decision and similar applications. It can also be made in an environment together with the existing applications such as Spreadsheet MS Excell, based on the spreadsheet itseld or by creating the macro function of Visual Basic Application (VBA).

In "AHP to Take Decision in A Complex Situation" book (Saaty, 1986), AHP means a simple and flexible method which accommodate creativity on approaching a problem. AHP collaborates consideration and personal judgement in a logical way, influenced by imagination, experience and knowledge to arrange a hierarchy of a problem based on logic, intuition, and experience to give consideration (Tominanto, 2012). AHP has many strengths in describing the decision making process as it can be shown in graphic so that it can be easily understood by many people involved in the decision making (Atmaja, 2008).

Compared to another multi criteria method, AHP has a structural hierarchy as a consequence of the chosen criteria and the detailed sub-criteria (Makkasau, 2012).

The steps of a decision making using AHP (Suryadi and Ramdhani, 1998) are as follows:

- Arranging a hierarchy of the problem, started with the general goal, continued by criteria and sub-criteria and followed by alternative choices which is needed to be ranked.
- Determining element of priority.
    - Shaping paired comparison matrix describing the influence of each element on the criteria and sub-criteria used.
    - Filling paired comparison matrix using numerical score which describes relative importance of one to another element. The comparison score is 1 to 9 (Saaty, 1986).
    - Normalizing data by dividing score of every element in the matrix which is paired with the total score of each column.
    - Calculating Eigen Value score by adding the score of each matrix and dividing it with the total element to get the average score. Eigen Value provides consistency measurement of comparison process (Nugraheni, 2012).
    - Calculating Eigen Vector of each paired comparison matrix. Eigen Vector score is the amount each element. Eigen Vector determines the rank of chosen alternative (Nugraheni, 2012).
    - Calculating Index Consistency under the following formula:

$$CI = (\lambda mak - n)/(n - 1) \quad (1)$$

Where,
CI = Consistent Index
λmax = maximum Eigen Value
n = the number of parameter

- Calculating Ratio Consistency under the following formula:

$$CR = CI / RI \quad (2)$$

Where,
CI = Consistent Index
RI = Random Index
CR = Consistency Ratio

$$CR = \frac{((\lambda mak - n)/(n-1)}{RI} \quad (3)$$

The Random Index Score (RIS) can be obtained in Saaty's table (1994).

It must be lower than 5% for 3x3 matrix, 9% for 4x4 matrix and 10% for bigger matrix. If RIS is higher than that, the matrix comparison score must be re-calculated (Tominanto, 2012). Moreover, there should be score revision as higher inconsistency level leads to error (Saaty, 1994).

The weakness of AHP lays on its dependence of its main input because the main input is someone's perception so that it involves an expert's subjectivity where this model can be meaningless when the expert gives wrong judgement (Putri, 2011).

Sensitivity Analysis is a dynamic element of a hierarchy. It means that the score which was done for the first time is maintained for a certain period of time where any change of policy change is done by using Sensivity Analysis to see its effect (Mora, 2009).

Sensitivity Analysis is aimed at seeing the influence of every element on the priority hiearchy which was built (Makkasau, 2012).

Population Score is all good score, resulted from the calculation and measurement as well as the quantity of certain characteristics of all member of complete and explicit group whose features needs to be observed (Hasan, 2003). Based on the number of a group member, (Usman, et.al., 1996) said that population can be divided into Restricted Population (limited) and Unrestricted Population (unlimited).

According to (Sugiyono, 2009 in Putri, 2011), Sampling Collection Technique is a technique to collect sample in a research so that the sample is representative for the population it represents. They divided it into 2 (two), Probability and Non-Probability Sampling Technique. The first one collects sample where each sample has the same chance for each item/member of population (for a quantitative research), while the second one collect sample where each sample has different chance for each item/member of population (for a qualitative research) (Sugiyono, 2009 in Putri, 2011).

3. Method of Research

There are 2 (two) kinds of data in this research, Primary and Secondary Data. The first one were obtained by distributing questionnaire/question containing choices of opinion to respondents who are competent in their job. The data were also taken by holding a discussion with the respondents to get more accurate data. The second one were collected from offices.

(Sugiyono, 2009 in Putri, 2011) defined Sampling Collection Technique as a technique to get sample in a research in order to get a representative sample for the population it represents. This research use Purposive Sampling Technique, that is a technique of collecting sample under certain consideration, based on the research requirements which will be done where not all of respondents understand the topic of the research.

According to (Sugiyono, 2009 in Putri, 2011), respondents who are considered as an expert are they who are competent in their field. They can be competent in their authority/policy to make a decision, competent in their daily job (routine duty)/profession or they can have an academic competency suitable with the topic of this research. The respondents in this research are officers in The Office of *Balai Besar Wilayah Sungai Pemali Juana*, The Office of PSDA *Propinsi Jawa Tengah* and *PDAM Tirta Moedal* Semarang who are competent in their field. The questionnaire was distributed directly where respondents directly filled the form and held a discussion with the researchers. The numbers given from respondents' perception becomes the comparison scale of each factor of criteria and sub-criteria. The score of the respondents' answer is drawn based on the score of the camparation scale/range given by the respondents in the questionnaire. In this research, the respondents' education background should be observed as (Sugiyono, 2009) stated that one of important factors of competent respondent is their academic competence which is suitable with the topic of this research. The procedures of this research can be obtained in the research flow chart in Fig. 1.

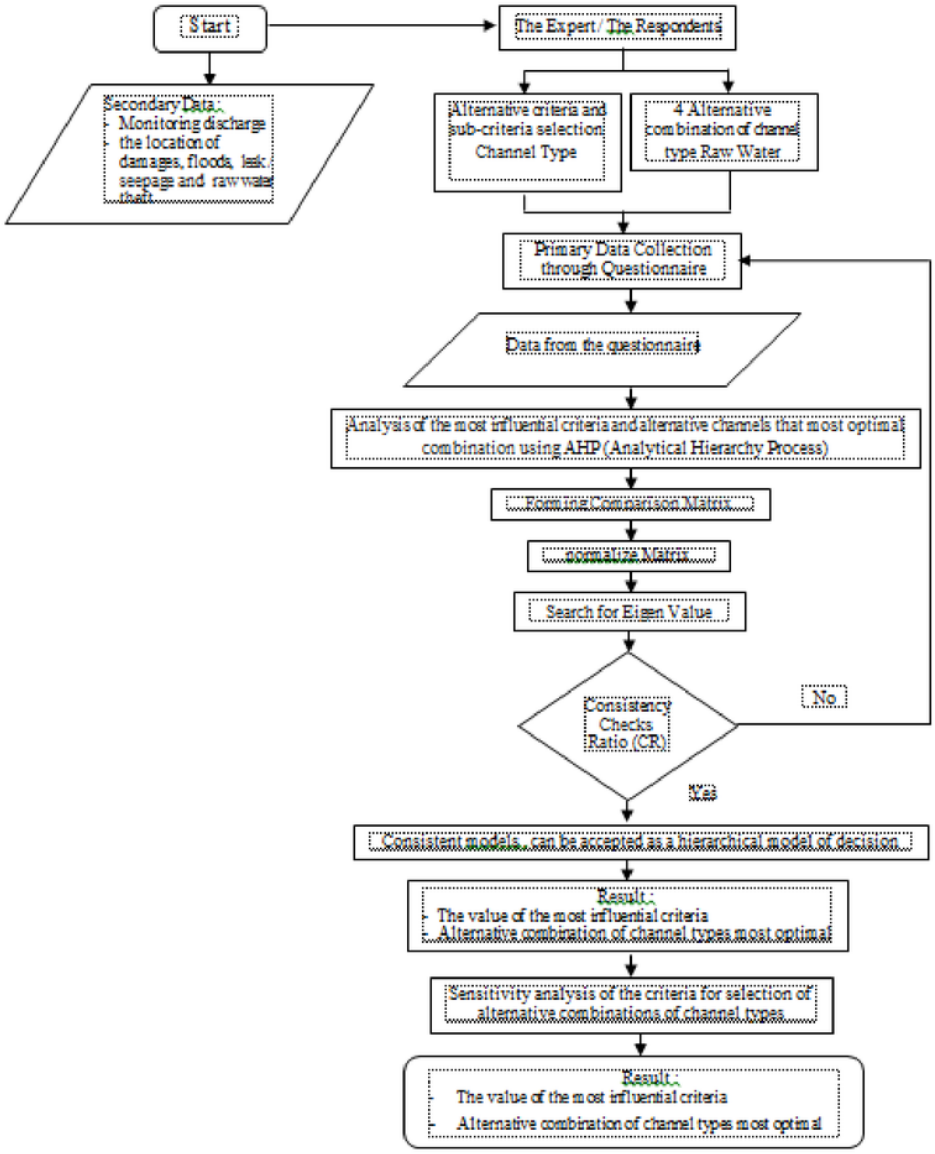

Fig. 1. The research flow chart.

4. Result of The Research and Discussion

The scores on criteria and sub-criteria were obtained from the score of scale/range of comparison scoring on respondents' questionnaire result. The score of comparison scale can be varied from important to more important. The standard score for comparison is 1 to 9 based on Thomas L. Saaty scoring number.

The first highest comparison score on the criteria of choosing channel type combination for "Klambu Kudu" system is the criteria of operation and maintenance implementation cost (0.291). The second highest score is operation and maintenance implementation cost (0.248). The third highest score is development implementation cost (0.177). The fourth highest score is the ease of development implementation (0.176). The fifth highest score is benefit/profit (0.107).

Based on the result of using AHP Method on each sub-criteria of choosing the alternative of channel type combination of "Klambu Kudu" system , the researchers obtained 4(four) most optimal result as follows:

- The first priority is alternative channel type 4 (0.448), that is a closed channel of clean water pipe on WMI near "Klambu" Dam, Grobogan District.

- The second priority is alternative channel type 1 (0.186), that is the existing channel with repairmen/improvement in several locations.
- The second priority is alternative channel type 3 (0.195), that is the alternative channel 3 (km 0,600 – km 24,007), the piled channel should use lining concrete contruction and the channel dike should use the power of concrete pole. The excavated channel (km 24,007) should use sheet pile construction, concrete lining and single tee concrete cover. This alternative channel type is used for "Kudu" WMI in Semarang City where the location of channel km 26, 902 – km 39, 275 is moved to the north of the street.
- The second priority is alternative channel type 2 (0.187). On the alternative channel 2, the piled channel (km 0,600 – km 24,007) should use concrete lining construction and the channel dike should use concrete pole reinforcement. Meanwhile, the excavated channel (km 24,007 – km 40,558) should use sheet pile construction, concrete lining and single tee concrete cover. This alternative channel type is used for "Kudu" WMI in Semarang City while building drainage for farming on km 26,902 – km 39,275 to channel excessive water in rainy season from farming areas.

The following picture shows "Klambu Kudu" system.

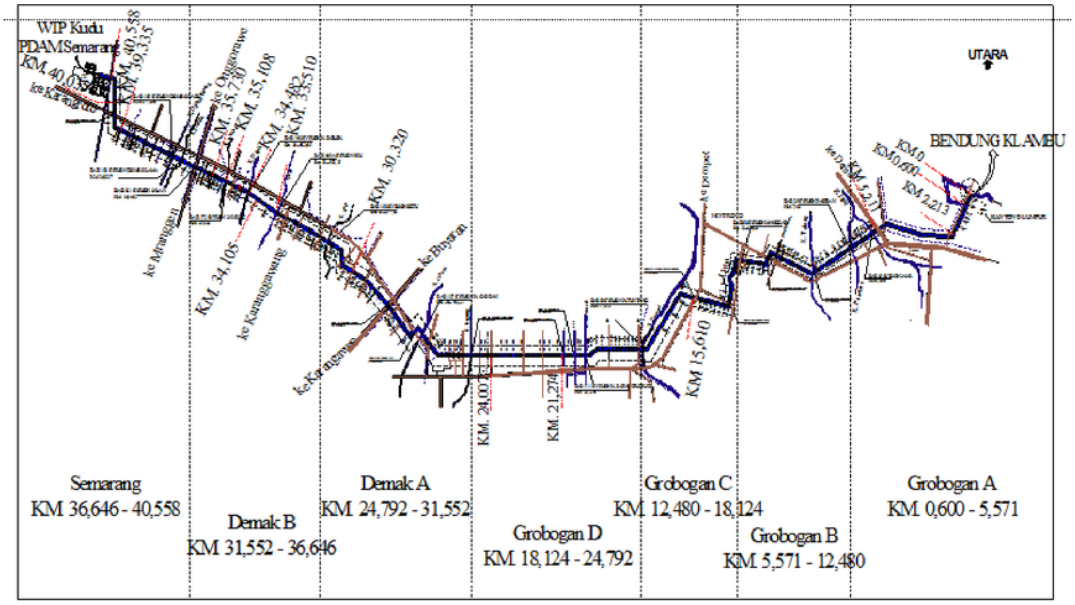

Fig. 2. "Klambu Kudu" system.

The chosen criteria and channel type alternative is tested by using Sensitivity Analysis by changing the score (by adding or subtracting the score). If the score of the operation and maintenance cost is raised by 3% from 0.291 to 0.300, the priority is globally unchanged, that is the alternative channel 4 still becomes the first priority. If the score of the operation and maintenance is raised by 20% from 0.291 to 0.350, the priority is still globally unchanged. It will stay the same when the score of the operation and maintenance cost is 31% or 40% lower, that is the priority remain the same.

5. Conclusion of The Research

From the result of the data analysis in this research, the researchers draw 3 (three) conclusion as follows :

- By using AHP Method, the alternative 4 of raw water channel type combination is obtained as the suggested alternative to be used, that is a closed pipe channel of clean water.
- The most important criteria in choosing the alternative raw water channel type combination is the operation implementation and maintenance cost criteria.
- After testing the result by using Sensivity Analysis, is can be concluded that criteria and sub-criteria in choosing the alternative raw water channel type combination in "Klambu Kudu" is not sensitive. That the conclussion in (a) is unchanged.

The analysis of channel type combination alternative of “Klambu-Kudu” raw water channel

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