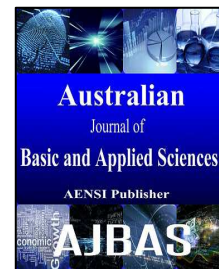




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An Economic and Social Cultural Analysis on Determining the Policy of Raw Water Availability

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ABSTRACT

Background: The provision of Drinking Water Resources in Indonesia is a very complex problem. It requires the efforts to solve and anticipation that must be seen as a whole and involves the participation of all parties concerned. Indonesia is one of the projected countries which will undergo the water crisis in 2025 caused by the poor water-management, especially for the inefficient water use. The growth of rapid population and the life style demanding the water use in great quantities relatively add more compulsion toward the water quality and quantity. The aim of this study is to know how great the influence of economy and socio-culture variables on the water availability needed for raw drinking water resources in Surabaya. **Results:** The findings of the research show that there is a positive significant effect of the Economy variable on the water availability with the loading factor 0.48 as well as the Socio-Culture variable has the significant influence on the water availability with the loading factor 0.21. Simultaneously, both variables are proven valid and have the significant effect on the availability of raw drinking water resources in Surabaya. It is indicated by the fulfillment of all goodness of fitting model describing the effects of the two variables on the availability of raw drinking water resources in Surabaya. **Conclusion:** The availability of raw drinking water resources in Surabaya mostly supplied by Kali Surabaya is influenced by the economy activities along the stream of Kali Surabaya. In addition to economy activities, its people's behavior in both their water use and care of Kali Surabaya environment influences the water quality and quantity in Kali Surabaya.

INTRODUCTION

Management of the environment is an important part of national development activities, as defined in article 33 Chapter 28H of the 1945 Constitution. In this article, it is stated that everyone has the right to live physically and spiritually prosperous, to have a home, and to get a healthy and eligible good environment, and to access health services. In addition to Article 33 Chapter 4 of the 1945 Constitution, Amendment 4 confirms that the national economy shall be organized based on economic democracy with the principles of togetherness, efficiency with justice, sustainability, and environmental insight, independence and by keeping a balance between progress and national economic unity. To anticipate the environmental damage that is increasingly worrying, the government establishes the Law Number 23 Year 1997 on Environmental Management.

The concept of sustainable development has long been the attention of experts. However, the term sustainability had just appeared a few decades ago, despite the attention to sustainability has been started since Malthus in 1798 showed a concern on the alarming availability of land in the UK as a result of rapid population explosion. One and a half century later, the attention to sustainability was intensified after Meadows in 1972

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published a publication entitled "The Limits to Growth" (Meadows *et al.*, 1972 in Turner, 2008). In the publication, it is concluded that economic growth will be limited by the availability of natural resources. As the availability of natural resources is finite, the flow of goods and services produced from natural resources cannot always be done continuously (on a sustainable basis).

One of the natural resource that is vital for the survival of living things is water, because water is essential for life. Humans can survive without food for several weeks, without water humans would die in a few days, and without air people will die in just a few minutes, so water is a basic right (Article 5 of Law No.7 / 2004), even according to the United Nations. The government has a lot of effort in the provision of basic needs including water. Problem of water for life is arising from increasing population and increasing standard of quality of life that is not balanced with the amount of water available. Besides, it also increase the pollution of water and air from household waste (Utomo, 2016).

Water resource management in Indonesia faces very complicated and complex problems, since water has several functions both socio-cultural, economic and environmental functions, each of which may be conflicting. With the onset of global climate change, the increasing population and the intensity of economic activities, there have been rapid changes in the natural resources. The most alarming is the fact that water resources have not got a decent protection both in policy formulation and implementation of spatial layout both in national and regional scale. As water is vital for living things, including humans, plants and animals, its use needs to be organized in order to provide benefits to people. In the water distribution network, we need a system that is coordinated, between both actors and policy makers in the water sector, and guarantee the acquisition of sufficient water.

As one of the metropolitan city, Surabaya has a very important role for economic growth in Indonesia. Increased water demand in Surabaya can be seen from the increasing demand for water for both household and industrial. Customers of PDAM in Surabaya experienced a drastic increase, of approximately 475 thousand subscribers in 2013 to 510 subscribers at the end of 2014. The rapid increase of the number of subscribers has not been accompanied by sufficient amount of water production, so the investment should be made to build Water Treatment Plant (WTP). Previously PDAM Surabaya is still trying to cope with increasing water demand through collaboration with Pasuruan by utilizing the water resources of Umbulan. The water supply from Umbulan Spring to PDAM Surabaya is currently only 110 liters/sec of the plan in the MOU of 1000 liters/sec, but until now the plan is not yet realized, so the need for raw drinking water source is still dependent on the availability of river water coming from Kali Surabaya.

Based on the results of population projections in the next 25 years from 2012 using geometrical methods, the population of Surabaya from 3,125,576 in 2012 with a population growth rate of 0.65, then Surabaya's population in 2025 are projected to increase to 3.339.249.96 (BPS Surabaya, 2014) and will become one of the most populous cities in Indonesia. Increasing number of population will bring a serious impact on support of the environment, because the increase in the population will increase the consumption of drinking water or net impact on the increase for wastewater.

According to the Regulation of the Minister of Public Works No. 14 / PRT / M / 2010 on Minimum Service Standards for Public Works and Spatial Planning, the need for water is set at 60 liter/person/day, then demand for clean water as much as 203 434 998 liters/day. The main issue of the water supply system and water supply is the availability of water resources that meet the quality and quantity needed.

Kali Surabaya, which is now a major supplier for drinking water needs in Surabaya, is a segment of Brantas River from Dam Lengkong Mojokerto and empties in Surabaya. Surabaya River flows along 41 km and passes through four districts of the city that is Mojokerto, Sidoarjo, Gresik, and Surabaya. The upstream of Kali Surabaya is in DAM Mlirip, Mojokerto and the downstream is at Bridge Petekan, Surabaya. Kali Surabaya becomes a source of raw materials of PDAM Surabaya and more than three million consumers rely on it. In addition to clean water as a raw material, Kali Surabaya is also used for irrigation, industrial raw materials, a habitat for hundreds of biota, and fishing locations.

As the main raw material for drinking water of PDAM Surabaya, until 1970, Surabaya River water quality problems have not been taken seriously, due to the lack of complaints to water quality of Kali Surabaya. Things have been changing since mid-1976 marked with the number of dead fish and ceased production of PDAM due to water pollution cases. Sharp criticism was directed to the industry in the upstream accused as the cause of the pollution. Since then, Surabaya experiences heavy pollution every year, especially in the dry season when the water flow is small, resulting in the death of many fish and sharp decrease in PDAM water quality. The case of heavy pollution occurred in August, September, and October 1993, which caused death of fish and no production activities IPAM Karangpilang I. Government has regulated industry to have a waste treatment unit, and relevant government institutions have control over that, with the existence of treatment plants for industries along the river.

Environmentally Friendly Approach on Development:

Environmentally friendly development management for the availability of raw drinking water sources is crucial to the sustainability of ecosystems. This can be done through: prevention of environmental pollution;

rehabilitation and restoration of ecosystems and damaged natural resources; and increasing the production capacity of natural ecosystems and the human target. Regulation on comprehensive water resource management, which is environmentally friendly, is stipulated in Government Regulation no 42 of 2008 as mandated in the Law Number 7 of 2004 on Water Resource, with the objectives of:

- a. water resource can be managed and water can be used by considering the sustainability of such resources;
- b. there should be balance among the social functions, environmental functions, and economic functions;
- c. to achieve the most beneficial use of water resource effectively and efficiently;
- d. to achieve harmonious use for many interests by considering the nature of water resource that are dynamic;
- e. to protect the right of each citizen to get equal chances to play role and to enjoy the benefit of water resources; and
- f. to achieve openness and accountability of water resource management.

Economical Approach:

In this approach, each component of the environment is considered to have the economic price and evaluation is done to each environmental change. If people know that the price of environment is very expensive, it is expected that people will take care of their surroundings better. In environmental economics, environmental goods are considered as production goods so environmental factors are internalized or put in charge of production. Thus, environment is a very valuable item. Economical approach considers aspects of industrialization, agriculture, and technology used.

Social and Cultural Approach:

Social and cultural diversity in the community will affect the view in the utilization of natural resources and the environment. Thus, environmental management will be localized and specific to a particular region. It should be noted also their indigenous knowledge (local knowledge) as the traditional or local wisdom of communities in environmental management. For example in farming communities in Java, there is a system of crop rotation named *titi mangsa*. Overall approach to social and cultural sustainability is expressed in social justice, human dignity and improving the quality of life for all humans. Social and cultural approach has four objectives, namely:

- a. Stability of residents, whose implementation requires strong political commitment, awareness and public participation, strengthening the role and status of women, improving the quality, effectiveness of family environment.
- b. Meeting basic human needs, to combat poverty and reduce absolute poverty. Sustainable development cannot be achieved when there is a gap in the distribution of wealth or social class.
- c. Maintaining cultural diversity, to recognize and respect the social system and culture throughout the nation, and with the understanding and use of traditional knowledge for the benefit of the community and economic development.
- d. Increase participation of local communities in decision-making.

Research conducted by Kusumawardani (2010) on Perum Jasa Tirta Surabaya predicts that in 2025 there will be a deficit of clean water. In that year, the population of Surabaya will reach more than 3.04 million people and need of clean water reaches 47.05 cubic meters per second. On the other hand, the availability of clean water only reaches 39.62 cubic meters per second, so there would be a deficit of 7.43 cubic meters per second. While in terms of quality, although the production of water has meet drinking water quality standards in accordance with Kepmenkes 907/2002, customers do not get the same quality which is marked with the number of complaints received over the years. Environmental conditions in Surabaya received less attention, even prone to damage due to increasing population density thus increasing the volume of the waste and the big role that industrial development has occurred in this region. Study by Serrano *et al.* (2015) showed the relationship between industrial activities with the level of unemployment and industrial pollution. The increase of unemployment (1%) was caused by the decreased industrial activities which also decreased the level of pollution to 8.56%.

Clean water and pollution problems in the end lead to a major economic impact and community, and this must be borne by consumers. From an economic standpoint, this phenomenon indicates that today water is no longer a free good, but has become an economic good, as to obtain it requires sacrifice. The concept of water as an economic good is one of the basic principles of water management, in addition to equity and environmental sustainability as stated in the World Summit on Sustainable Development in 2002 and Third World Water Forum in 2003 (Lange and Hassan in Kusumawardani, 2010).

Sustainability of supply of river water as raw water to be processed as drinking water in Surabaya as in other major cities in the world must be considered and pursued seriously. The quality of product from the PDAM is

consisted of reliability and durability (Garvin in Rahman, 2014) will guarantee the availability of drinking water supply. Osooli *et al.* (2011) identify factors that affect the management of raw water (Sustainable Water Resources Management) which includes education, economic, farming, Socio-Cultural, and technical. Results of research conducted in Iran Nooshim state that these five factors could significantly affect the sustainable management of water resources. Factor of technique has the most to do in the management system for water supply (Sustainable Water Management Resources). Another study conducted by Sutardi *et al.* (2006) states that people's behavior, physical condition of the network, and community participation in the management of irrigation network has a significant influence on the management of irrigation systems to ensure the availability of water for public purposes.

This research will formulate a model of environmental sustainability for water resource management in order to achieve sustainable development to include consideration of the socio-cultural and economic aspects to tackle water availability in Surabaya.

Research Problems:

Based on the above description, the research questions can be formulated as follows "How to develop a model of environmental management to ensure sustainability of supply of raw water source in Surabaya by considering aspects of sustainable development?". In order to answer the main question, supporting research problems as follows:

1. How is the influence of economic variables toward raw water supply in Surabaya?
2. How is the influence of social and cultural variables toward raw water supply in Surabaya?
3. How does the model of availability of raw water in Surabaya look like?

Research Model:

Research Design:

This research was conducted using a survey approach by distributing questionnaires to stakeholders (respondent) of different occupations.

Types and Source of Data:

Data used in the study was quantitative of Likert scale. Based on the sources, the data consists of primary data and secondary data. Primary data is directly obtained from the sources. The data was obtained from respondents through interviews and questionnaires. Secondary data is collected from existing literature. Secondary data is the data source that does not directly provide data to researchers or is obtained from other sources.

Sampling:

Primary data in this study was obtained through structured interview techniques and questionnaires to stakeholders. Sampling technique in this study was purposive sampling method. The population in this study was the department, agency, elements of the public as stakeholders of water in Surabaya. In addition, this study used secondary data obtained by the method of documentation or direct quotations from a variety of sources through library research by studying and examining the literature in the form of books, journals, and papers.

Structural Equation Modeling (SEM):

The method used in this research is Structural Equation Modeling (SEM). SEM is a tool in the collection of statistics to examine the relationship between one or more independent variables and the dependent variable. SEM is a statistical technique to study the causal relationship between latent variables (unobservable variables). Latent variables are variables formed or described by the indicator variables (observable variable). In principle, SEM is a combination of factor analysis, path analysis, regression analysis, and correlation. In SEM, some terms are used for random variables, namely:

1. Latent variable is a concept cannot be measured directly but rather is measured by variables observed that theoretically form the latent variables. Unlike the linear model, SEM allows the correlation between exogenous latent variables.
2. Manifest variable or indicator is a variable that can be measured directly as income, age, and price. Observable variables making up the so-called latent variables are manifest variable or indicator.
3. Error variable is a variable that represents the variability of the latent variable that cannot be explained by its constituent indicators.

Research Model:

The formulation of the model in this study uses Structural Equation Modeling (SEM). SEM method is used by the consideration that the purpose of this study is to find the level of influence between the latent variables. The conceptual model of the research can be seen in Figure 1.

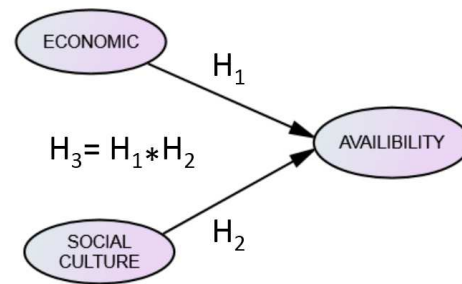


Fig. 1: Conceptual Model (Osooli, 2011)

Research hypothesis:

Hypothesis testing in this study aims to determine the effect of exogenous variables partially on endogenous variables defined as follows:

H1: Economic variables have a significant influence on Raw Water Supply as Drinking Water.

H2: Socio-cultural variables have a significant influence on the Raw Water Supply Drinking Water.

H3: Social and cultural variables have a significant influence on the Raw Water Supply as Drinking Water.

The Operational Definition of Variables:

Water resource management in Indonesia face very complicated and complex problems since water has several functions of social and cultural, economic and environmental, each of which may be conflicting. With the onset of global climate change, the increasing population, and the intensity of economic activity, there has been a change in the natural resources very quickly.

The variable used in the model is a latent variable, so in order to do the measurement, and then the latent variable should be operationalized by parameters.

Socio-cultural Variable:

Socio-cultural by Andreas Eppink is defined as everything or the values prevailing in a society, including the statement of the intellectual and artistic values becoming the hallmark of the community. Edward Burnett Tylor explains that culture is a complex whole. Art, morals, customs, laws, education or knowledge, confidence and ability or the result of a thought in the other forms someone earns as a member of society.

The development objectives in the social and cultural fields are for the welfare of the people as indicated by increasing quality of life and dignity, and adequate basic needs of society. Socio-cultural variables are measured using the parameters of education, population, health, and the level of community participation.

Economic Variable:

Economy in this study means that each component of the environment is considered to have the economic price and evaluation is done to each environmental change. If people know that the price of environment is very expensive, it is expected that people will take care of their surroundings better. In environmental economics, environmental goods are considered as production goods so environmental factors are internalized or put in charge of production. Thus, environment is a very valuable item.

Increased competition among water users makes the economic consideration as the first to see in the allocation of water. Water can have a higher economic value when sold directly as a commodity item. Research conducted by Osooli (2011) states that economic variables significantly influence the availability of water in Iran.

Economic activities directly related to water resources are agriculture and industry. The sustainability of water resources availability as raw water is not only affected by agricultural and industrial activities but also are also highly dependent on the technology used. Thus, in this study the economic variables can be measured using indicators of agriculture, industry, and technology.

Availability Variable:

The availability of water resources for drinking water is not only due to the sufficient volume of water, but is also influenced by many factors. The definition of water availability in this study is sufficient water in quantity and quality to the community and industry need. Availability depends on production system used, distribution system used, consumer behavior, spatial regulation, and institutions that regulate and deal with the problem of water resources. The availability of water is measured using indicators: production, distribution, consumption, spatial, and institutional handling.

RESULTS AND DISCUSSION

Processing of research data used SEM. Test on research model used α value of 0.05. Before processing the data to the model simultaneously and synchronously, test the validity and reliability of the model must be done beforehand.

Reliability and Validity Test:

Test on reliability of variables that make up the model in the study was done by calculating the value of Cronbach Alpha. A variable is said to be reliable if the Cronbach Alpha value is ≥ 0.70 . The result of the calculation of Cronbach Alpha of the variables in our model are as follows:

Table 1: Reliability Test Results

Reliability Statistics		
Variable	Cronbach Alpha	N of Items
Economic	0.800	3
Social Culture	0.870	4
Availability	0.932	5

From the calculation of all latent variables, the Cronbach Alpha values are ≥ 0.70 . this indicates that all latent variables used in the model are reliable. While the validity test is used to determine whether the measuring instruments used is completely able to measure what it intends to measure. In this study, validity test on constructs was conducted by Confirmatory Factor Analysis (CFA). The CFA test results for the three construct are as shown in Table 2. All variables are valid. Table 3 shows that the indicators used in the measurement of latent variables in the model are valid.

Table 2: Validity Test Results on Economic Variable

ECONOMIC			
Goodness of Fit	Standard Goodness	Value	Conclusion
Chi-Square	Small	0.494	Fit
RMSEA	≤ 0.08	0.000	Fit
GFI	≥ 0.90	0.999	Fit
CFI	≥ 0.90	0.999	Fit
CMIN/DF	≤ 2.00	1.494	Fit

Table 3: Validity Test Results on Social Cultural Variable

SOCIAL CULTURE			
Goodness of Fit	Standard Goodness	Value	Conclusion
Chi-Square	Small	1.292	Fit
RMSEA	≤ 0.08	0.000	Fit
GFI	≥ 0.90	0.996	Fit
CFI	≥ 0.90	0.926	Fit
CMIN/DF	≤ 2.00	0.646	Fit

Table 4: Validity Test Results on Availability Variable

AVAILABILITY			
Goodness of Fit	Standard Goodness	Value	Conclusion
Chi-Square	Small	11.735	Fit
RMSEA	≤ 0.08	0.076	Fit
GFI	≥ 0.90	0.974	Fit
CFI	≥ 0.90	0.977	Fit
CMIN/DF	≤ 2.00	2.034	Fit

The output of the research model is shown as follows:

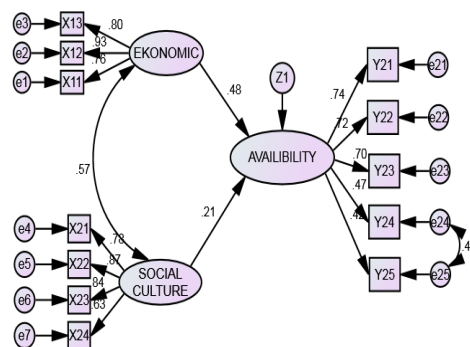


Fig. 2: Data analysis results using SEM

Table 5: Goodness of Fit Full Model

GOODNESS OF FIT FULL MODEL			
Goodness of Fit	Standard Goodness	Value	Conclusion
Chi-Square	Small	106.2	Fit
RMSEA	≤ 0.08	0.074	Fit
GFI	≥ 0.90	0.916	Fit
CFI	≥ 0.90	0.942	Fit
CMIN/DF	≤ 2.00	2.054	Fit

Source: Data processed (2015)

Based on five measures of goodness of fit of the model above, it appears that, overall, the model is good, which is marked by the fulfillment of all goodness of fit model. All variables have positive contribution to the availability of raw water for drinking water in Surabaya. The model can explain the significant effect of economic and social cultural variables toward the availability systems for drinking water in Surabaya. In addition to significant influence, the model can also explain the effects of the two variables together (simultaneously) toward the availability of resources of drinking water in Surabaya. The following data is the result of the calculation with AMOS 21.0.

From the model, an equation model is generated as follows:

Availability = 0.48 * Economic

Availability = 0.21 * Social Cultural

Availability = 0.48 * Economic + 0.21 * Social Cultural

The Effect of Economic Variable toward Raw Water Availability:

The results show that economic variable has significant effect toward raw water availability. The research model equation can be written as follows:

Availability = 0.48 * Economic

The constant figure 0.43 is a loading factor that describes the amount of direct influence of economic variable toward availability. Increased economic activities consisting of agricultural and industrial activities will then require greater availability of water resources. Thus, H1 is accepted.

Of the three indicators used as a measure of economic latent variable, indicators of industrial activity have the greatest loading factor of 0.93, followed by agricultural activities of 0.80, and the use of technology with a loading factor of 0.73. These results indicate that industrial activities have the greatest influence on the availability of water, so it needs special attention. Associated with the industrial activities, with significant indicators of the use of technology, the need for water resources for the industry by optimizing the use of technology, as well as agricultural activities.

A policy to regulate the use of environmentally friendly technologies as well as waste treatment technology needs to get the attention of government so that the availability of raw water sources can be guaranteed sustainable

The Effect of Social and Cultural Variable toward Raw Water Availability:

The results show that social and cultural variable has significant effect toward raw water availability. The research model equation can be written as follows:

Availability = 0.21 * Social Culture

The constant figure 0.21 is a loading factor that describes the amount of direct influence of social and cultural variable toward availability. Increased social and cultural activities consisting of education, population, health, and community participation can be a positive influence on water availability.

The results of data processing to variable social cultural on the model shows that the population indicator has the biggest loading factor of 0.87, followed by health of 0.84. The biggest loading factor of population shows that it brings the highest effect toward the availability of water; population growth will not only increase water consumption, but will also add for activities that require water resources. The participation rate of people having the lowest loading factor of 0.63. This shows the existing role of the society for the preservation of water resources, but dissemination to the public against the threat of water scarcity as a raw water source in the future is indispensable—if there is no awareness and community care to help the government preserve the surrounding environment, things can go even worse.

Public participation has been carried out through culture that grows in the community, often referred to as the local wisdom that governs water use, especially in agriculture, so that aspect of justice and equality can be felt by all parts of the society. Besides customs prevailing in the community, for generations people have been

setting out the use of forests, the method of determining the location for facility construction, and so on so it does not interfere with water catchment area that will ensure sustainability of water resources. Thus, H2 is proven.

The Effect of Economic and Social and Cultural Variable toward Raw Water Availability:

Simultaneous data processing results show the influence of economic, social, and cultural variable toward availability of raw water is significant and positive. The research model equation can be written as follows:

$$\text{Availability} = 0.48 * \text{Economic} + 0.21 * \text{Social Cultural}$$

The equation model above illustrates the direct influence of economic and social and cultural variable toward raw water availability. Increased economic activity and social cultural brings significant effect on the availability of resources for drinking water. Given these two variables have a loading factor that is quite large and statistically significant, then the program to address the availability of raw water sources effectively cannot be done partially but will be able to deliver maximum results if improvements are done to both variables in the model. Thus, H3 is proven.

Managerial Implications:

This study produced findings that should be followed up so that the supply of raw water for drinking water can be guaranteed. The findings of the study could help policy makers to make systemic improvements and effective plans.

In order to guarantee the availability of water as a raw water source referring to the study, several factors that have a significant influence on the availability of raw water in Surabaya must be considered. In terms of ensuring the availability of raw water source in Surabaya, government programs and policies will be more effective if attention to both aspects of improving economic activity with regard to the use of environmentally friendly technologies, population control, and improve community participation is made.

Ensuring the availability of raw water source must be done by taking into account the problems of production, distribution, and consumption seriously. Policies and regulations on spatial planning has a significant role to the problems of availability of raw water, so does institutional factors. Thus, to guarantee the implementation of regulations and policies, it is necessary to strengthening the role of institutions that deal specifically with the problems.

Conclusions:

From the above-mentioned discussion, the following conclusions can now be drawn:

1. Economic variable has a significant positive effect on availability. Industrial activity is the most dominant factor on the availability of raw water source.
2. Social cultural variable has significant positive effect on availability. Population growth is the most dominant factor on the availability of raw water source.
3. Economic variable as well as social cultural variable has a significant effect on availability. The results indicate that increased availability of raw water sources can be done by making the policy on economic activity, especially industrial activity in the use of environmentally friendly technologies. Besides the role of the public still needs to be improved so that the availability of raw water sources can be guaranteed in the future.

Suggestions:

1. There are several limitations to this study as it only examines the influence of the economic and social cultural variable toward availability of raw water sources. A more comprehensive model involving more other variables outside variables that have been used in this model must be made in the further studies.
2. Further research that focuses more on the synergy of environmental programs and spatial programs in big cities is needed.

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