Behaviour Analysis of Riverbank Society on Pollution of Water Quality in Ciliwung River Downstream, Jakarta

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Abstract

General problems which occur in urban areas, mainly in big cities of Indonesia, are due to river pollution activities in surround river communities. This study which conducted in downstream of Ciliwung River, the capital Jakarta, is experiencing tremendous pollution caused by household waste. Therefore, this study attempted to answer how is water pollution in Ciliwung River downstream, what factors affect people's behavior in utilizing and conserving water quality of Ciliwung River downstream, and effective ways to control pollution in the Ciliwung River to consider aspects of community participation. The approach of this study is a quantitative analysis of SEM. The results of analysis show that the household activities are the major contributor of pollution. Also, there are direct and indirect influences significantly between the variables of society behavior of the Ciliwung riverbanks and the existing pollution.

Keywords: behaviour analysis, Ciliwung River downstream, Riverbank Society, water pollution

1. Introduction

Interactions between human activities and environment always carry positive or negative impacts. Positive effect of the interaction can be realized by increased welfare, while the negative impact can be externalities harmful to environment and also for human (Angger, 2007). Environmental problems arise when the exploitation of natural resources ignore the principles of natural resource management and environmental sustainability (Bateman and Snell, 2004). It has become a global issue, and attract the attention of researchers and decision makers.

The interesting phenomenon in natural resources exploitation, which is rarely studied, is the environmental problems in the riverbank area. This problem generally occurs in urban areas, especially in big cities, including Ciliwung River in Jakarta, where human activities around the river polluted the water. Hendrawan (2005) reported, many economic activities are undertaken by communities around the river, thus inflict the negative impact to the river function. The negative activity, especially people's behavior in littering and building on riverbank, causes more pressure on Ciliwung River. Currently, the river is having constriction, siltation, and pollution that reducing optimal function of Ciliwung River. Ciliwung also experiences tremendous pollution. Household waste is assumed as the major cause of heavy pollution in Ciliwung. Government is having difficulties to persuade people leaving the littering habit into river. If this condition continues, some areas that use Ciliwung as water resources will experience clean water crisis.

The carrying capacity of the Ciliwung is decline – in the aspects of technical-functional for flood control, comfort and beauty of the environment, and water quality – and become problems that need attention. Therefore, it is necessary to research the social and technical aspects on Ciliwung riverbank.

Nowadays, the condition of Ciliwung is accumulation of negative externalities that occur for long time, and lack redress of negative impacts. In general, the issues in this study are related to the water pollution and the behavior of people on the riverbanks of Ciliwung (Rendanikusuma, 2008). Particularly, the issues are: 1. current level of water pollution; 2. factors that affect people's behavior in using and conserving the water quality; 3. effective way to control pollution that considers the aspects of public participation.

2. Theoritical Study

2.1 Water Quality Concepts

Domestic waste includes all household wastes which are dumped into the sewer, including small industrial

wastes that difficult to identified and counted separately. Considering difference between food and wash waste, and differences between traditional and small industries, volume of waste load per-capita will be vary (Wibowo, 2010). This allows using the factor of waste load average, in calculation of domestic waste load initial stage at each study area. In fact, the volume of waste tends to very vary, and generally it's associated to average living standard of people in study area.

Volume factor for domestic waste is 73 m^3 per-person per-years. If water consumption data are available for each area, calculating wastes done by multiplying the average using of water per-person per-year by 0,6. Furthermore, if the result of calculations is differed by more than 50% of the recommended factor (73 m^3), the smallest number will be used.

In estimating the domestic waste load – the number of people using latrines and septic tanks, especially when the waste is channeled into the sewage of the city – for further processing or disposal must be noted (Wibowo, 2010). Although the use of latrines and septic tanks will reduce the volume of waste, since most of the water is absorbed into the ground and some dirt turns through anaerobic digestion, latrines and septic tanks waste load is still counted (WHO, 1990). Currently, there have been estimated hundred-thousands of chemicals produced commercially, and each year approximately 1000 new chemicals are added and produced. Sooner, the chemicals will eventually get into the water (rivers, lakes and seas). The work to establish an acceptable concentration levels (acceptable level) is also becoming more difficult, as each organism has a different tolerance to contaminants (Sugiyanto, 2010).

The sources of water pollution can be classified into: 1. fixed source or originating from identified location (point source); and 2. Unfixed sources (non point source). Measurement of people's behavior impact on riverbanks to ecosystems damage and river water pollution is including geo-physics-chemistry variables (type and volume of waste that goes into the river) and physical and chemical quality of river water. Aspects of geo-physical-chemical and biological environments that have interaction one to another, have the ability to grow and develop, and can be used by communities to acquire their needs. Biological environment variable is mainly focused on aquatic and terrestrial biological environments, i.e. water quality.

2.2 Society Behaviour

The practices that cause discontinuities of people's behavior have been manifested in their interactions with the natural environment. Sustainable social practices in dealing with the issues in reality have created a social culture (Armstrong, 2006), "The sum of socially transmitted practice that people create to deal with real-life problems" (Brym & Lie, 2007). Individuals live with set of values, shared beliefs and norms, which predispose them to think, feel, and behave with each other, and to those people outside the entity (George & Jones, 2005).

The strength of shared values, beliefs, and norms which is built within the community will be reflected in the loyalty and engagement of the community as well as self-identification of programs and policies promulgated by the local government (Cunliffe, 2008; Daft, 2010). Loyalty, engagement and self-identification are defined as a commitment of the community to the implementation of government policy on the local environment. Commitment and culture will manifest in behavior (Jason *et al.,* 2011). In order to realize such behavior, the public will observe if their behavior is a rational choice and get balanced exchange. Behavior patterns evolved reaction to events and actions beyond a period of time (De Janasz *et al.*, 2009).

Behavior of society members is complex, because it is influenced by variety of environment variables, and many individual factors, experiences, and events. Several individual variables such as skills, personality, perceptions, and experiences affect behavior (Gibson *et al.*, 2009). Skills refers to the general capability and sustainable to do something (Byars & Rue, 2008). Personality includes mixing of all characteristics that covers person's unique nature as reaction and interaction with others (Schermerhorn *et al.*, 2011). While the perception is thought process that organizes and gives meaning to the information captured by the senses (Morris & Maisto, 2009). Assessment of ethical or unethical behavior is based on the principles, rules or guidelines derived from the theory of ethics, character traits or social values. The definition of ethical and unethical behavior filed two issues; (1) difficulty in obtaining standard assessment that can be agreed upon scientists, and (2) the issue of whether something is good or bad; right or wrong; has a different meaning between people and between communities (Champoux, 2006). Some differences are applied for unethical behavior, the person referring (subjectively unethical), and unethical behavior that violates the rules and laws that have been established (objectively unethical). The differences may occur when a person believes that he has behaved ethically, but others who observed actually believe that the behavior has violated regulations (Champoux, 2006).

Behavior as a result, directed by goal can be measured and observed indirectly (e.g., thinking, and monitoring) (Ivancevich *et al.*, 2008; Kreiter and Kinicki, 2008; Kreitner, 1995; Mondy and Premeaux, 1993). It is also important in achieving the goal, and motivated or encouraged behavior (Gibson *et al.*, 2009). The behavior of community members is function of individual members of concerned community and the environment (Luthans, 2011; . *A citizen's behavior is a function of individual and environmental variables* (Gibson *et al.*, 2009).

2.2 Regulation Concept

Regulation is embodied in the law, aiming to seek a balance of all kinds interests presented in the community (Ife, 1997). Community is quite a lot of people, who live in the same area, which is relatively free and participate in shared culture (Schaefer, 2009). Togetherness is the nature of human, since born till died. Since the first, in human self there is a desire to get together with others in a group. In addition, people also have a passion for community (Jackson *et al.,* 2009). Humans as individuals may have the nature to live alone, but humans as social beings unable to live alone. Social life is mixed up and hangs out with each other to be able to acquire all the needs in order to live as decent human beings (Chainur, 2001).

3. Research Method

This study analyzes the effect of independent variables to the dependent variable, where the effects are indirectly influenced by moderating variable that form a particular arrangement. The study also analyzes the impact of the dependent variable that has been affected by the independent variables, and strengthened or weakened by the moderating variable. Researchers use survey method, to describe and explain the phenomenon that has occurred (*expo de facto*) and experienced by the respondents, as well as the laboratory tests on the water quality of Ciliwung River.

This study was conducted in Jakarta, to people who live on Ciliwung river banks, especially in the District of Jatinegara, East Jakarta. Determination of the Ciliwung River based on consideration that Ciliwung is one of the most polluted rivers in Indonesia, with the highest population density in the riverbanks. The number of samples in this study is 136 people; refer to Ferdinand (2002) research sampling for analysis of SEM is at least 100 samples.

3.1 Laboratory Analysis

Data collection of Ciliwung river water quality is primary data by field measurements. Primary data were tested in the laboratory of Bapedalda, Jakarta. Tests were done by referring to Governor Decree of KDKI of Jakarta No. 582 of 1995 about The Quality of River Water, and the Minister of the Environment No. 112 in 2003. Water quality sampled from domestic sewage into the bodies of river or flows through the conduit into the river. River water sampling was conducted in 6 (six) points, which represents the characteristics of the river.

Optimal value of land use along Ciliwung river bank was calculated by *p value* (Arbucle and Worthke, 1997). The analysis is based on the characteristics of the Ciliwung River with the assumption that current trends will continue in the future. This is important in drafting the concept of Ciliwung river future management. Riverbank existing condition – land use contained in the spatial and Detailed Spatial Plan of District of Jatinegara 2005-2015 – is consideration. Management of the river tries to find community role in riverbanks management that can be tolerated by generating the benefit optimal of ecological river.

This research need to produce formulation regarding the impact of the utilization of Ciliwung riverbanks by controlling the level of water pollution, so the utilization can be preserved. Therefore, it is also necessary to analyze the community behavior of the Ciliwung riverbanks, in addition to appropriateness and institutional and economic conditions. To formulate the impact of society behavior on the quality of river water, it is necessary to analyze the function of each area. The association form can be seen from the impact of any activity on the land to the water, preferably in the river to the land on it.

3.2 Test of Validity and Reliability Instruments

To test reliability of the studied variables, Cronbach Alpha testing is used by the formula of Arikunto (1993):

$$r_{11} = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right)$$

(1)

r11   = Instrument Reliability σ_b^2 = Total variance of grain

k   = Amount of questions σ_t^2 = Total Variance

Instrument considered as reliable if it has the reliability coefficient of 0.6 or more (Arikunto 1993).

3.3 Data Analysis of Structural Equation Modeling (SEM)

Structural Equation Modeling or SEM is a set of statistical techniques that allow testing of a relatively complex series of correlation, simultaneously. Solimun (2003) suggested using SEM to determine correlation between one or more dependent variables depend on one or more independent variables, and can take form of factor or construct which is built from several indicator variables. Variables can have the form of an observed single variable or directly measured (Ferdinand, 2002).

4. Result and Discussion

4.1 Laboratory Test

Analysis of space utilization per-unit area obtained the degree of non-compliance space with the destined function and destined plan. The dominant elements are; a. Lack community awareness in the management of disposed waste, or there is a tendency of the public to always dispose the waste into rivers; b. Ineffective regulation, because culture which is embodied in people's behavior towards the river.

Such impact can be seen by increase level of waste in Ciliwung (BOD, pH, TSS, oil content and rate of fat). The change was supported by the growth of population and pollution load (weight/person/time) as explain in Astono *et al.* (2008). This linkage pattern, tend to be judged from the rivers condition in Ciliwung. Naturally, this substrate transfer function to keep the river area in order to always get the benefit of any undertaken activity. However, Bhakti (2005) suggested that the changed will occurred, if there is an effective intervention in the usage policy and utilization of space along the Ciliwung which base on the characteristics of land suitability with the carrying capacity, those are:

1) The ability of natural physic of water, and the river ecosystem in accordance with the principles of ecological carrying capacity.

2) Increased human activity in the area of Ciliwung riverbanks is an increased need for the land itself.

Hydrodynamic process is the key in influencing the presence and concentration of waste in river environment. Riverbank areas in the narrow form (closed), for example, would complicate the waste to out of the waters system where the flushing is driven by the river water flow which becomes weak, in contrast to the open river. The results show that the activity which has major contribution is household activities. With assumption there are 205 people of citizens; the household waste amount of N is 1.201,3 kg yr^{-1} and P 485,9 kg yr^{-1}.

Assuming the amount of N and P that enter the water is 25% of the anthropogenic waste after assimilation, then the contribution waste from anthropogenic activities is 0.25 x 1.201,3 = 300,325 kg yr^{-1} (N) and 0.25 x 485,9 = 121,475 kg yr^{-1} (P) for every 205 residents. For Kampung Melayu Village – one of Ciliwung riverbank – with population of 58,554 people will release waste into the waters of 85.781,6 kg yr^{-1} (N) and 34.696,8 kg yr^{-1} (P). This number is based on the appropriateness of the carrying capacity of the land. Approaches analysis of N and P total waste load, as well as analysis of the availability of oxygen which is dissolved in the water and organic materials waste for residential development, is highly dependent on population.

The dominance of domestic waste is found in Kampung Melayu area, similar to Primbodo *et al.*(2006), from all sampling points. Trend of water pollution levels is illustrates the high number of residents' dispose of domestic waste directly into water bodies, causing the high pollution levels of Ciliwung. Fixed Station of Monitoring Ciliwung River Waters was built to control the quality of Ciliwung river water due to domestic waste through the Gulf of Jakarta.

4.2 Migration level and residential preference

Based on SEM analysis, Driving Factor has directly proportional correlation to Migration Level (r= 0.352, p-value= 0.009). This means if Driving Factor is higher, Migration Level is also higher. Pull Factor also has positive correlation to Migration Level (r= 0.219, p-value= 0.009). Conversely, coefficients of migration level to Residential Preferences are negative (-0.482). It indicates the opposite correlation, which means if Migration Level is higher, Residential Preferences value will be lower.

Indirect influences of Driving Factor and Pull Factor to the Residential Preferences through Migration Level are negative (-0.170; -0.105 respectively). It indicates the opposite correlation, which means if the driving or pull factor is higher; the value of Residential Preference is lower, if the migration value is also high (Fig. 1).
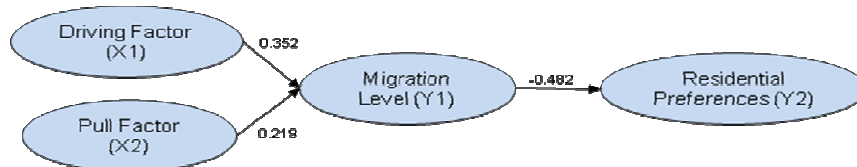
Figure 1. Indirect Influence of driving and pull factor to residential preferences
via migration level

4.3 Cultural values

Educational Perspectives, Social Environment and Economic capability are positively correlated to Cultural Values (r=0.281, p-value= 0.013; r=0.289, p-value= 0.009; r=0.277, p-value= 0.006 respectively). It means if the educational perspective, social environment and economic capability are high, the Cultural Values will be high also (Fig. 2).
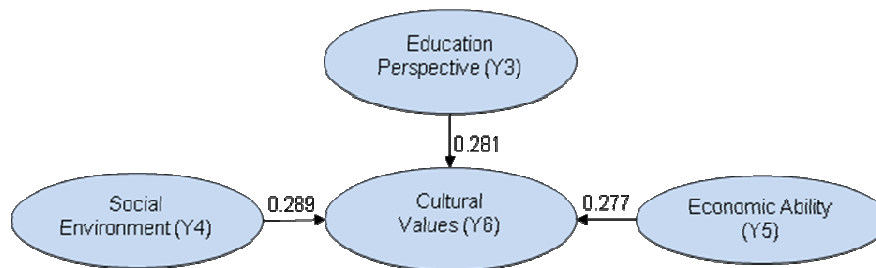

Figure 2. Correlation of education perspective, social environment and economic ability to cultural values

4.4 Local institution development

Educational perspectives correlated to local institutional development with 0.304 coefficients in p-value 0.016. This means, if the Educational Perspective is high, the value of Local Institutional Development will be high also. Similarly, Social Environment and Local Institutional Development are positively correlated (r= 0.353, p-value= 0.006). Economic Capabilities also has positive correlation to Local Institutional Development (r= 0.249, p-value= 0.023). This means, if social environment and economic capability are high, value of local institutional development is high too (Fig. 3).
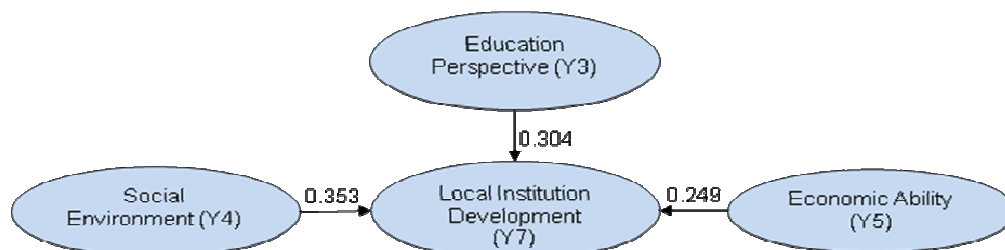

Figure 3. Correlation of education perspective, social environment and economic ability to local institution
development

4.5 Regulation commitment

Correlation coefficient between the Educational Perspective with Regulation commitment is 0.431 with p-value 0.001. It means, educational perspective is directly proportional to Regulation Commitment. Social Environment correlated to Regulation commitments by r=0.229 with the p-value 0.036. If social environment is high, the value of commitment Regulation will be high too. Otherwise, Economic capability was not correlated to Regulatory Commitment (r= 0.045, p-value= 0.615). This means, regardless the value of economic ability, it will have no effect on the value level of regulation commitment (Fig. 4).
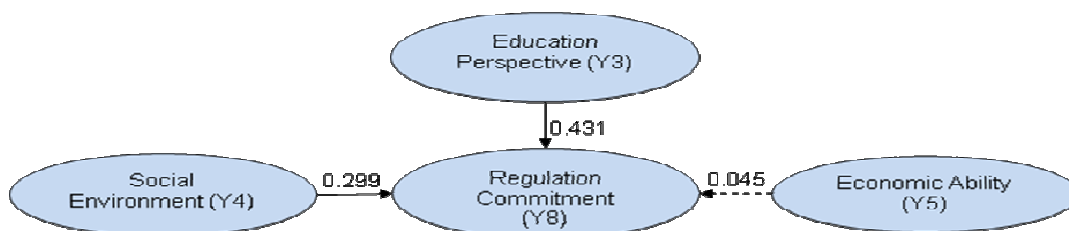

Figure 4. Correlation of education perspective, social environment and economic ability to regulation commitment (- - - = insignificant)

4.6 Society's Behavior

Educational Perspective, Social Environment and Economic capability are uncorrelated to Society's Behavior (r= 0.039, p-value= 0.767; r= 0.046, p-value= 0.678; r= 0.031, p-value= 0.733 respectively). This means, regardless the value of education perspective, social environment and economic capability, it will have no effect on the values of Society's Behavior (Fig. 5).
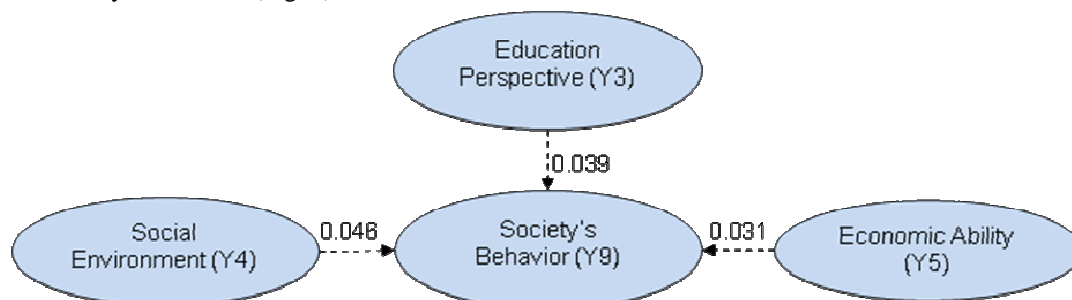

Figure 5. Correlation of education perspective, social environment and economic ability to society's behaviour (- - - = insignificant)

4.7 Correlation Between Indicator Variables

4.7.1 Direct correlation

Cultural Values is positively correlated to Regulation Commitment and Society's Behavior (r= 0.207, p-value= 0.032; r= 0.235, p-value= 0.017 respectively). It indicates that value of Cultural Value parallel to Regulation Commitment and Society's Behavior.

Local Institutional Development also positively correlated to Regulation Commitment and Society's Behavior (r= 0.270, p-value= 0.018; r= 0.246, p-value= 0.039 respectively). It indicates that Local Institutional Development is parallel to Regulation Commitment and Society's Behavior.

Regulatory Commitment strongly correlated to Society's Behavior with r=0.504 and p-value of 0.001. This means, if the value of the commitment of Regulation is high, the value of Society Behavior is high too. These direct correlations among indicator variables provide in Figure 6.
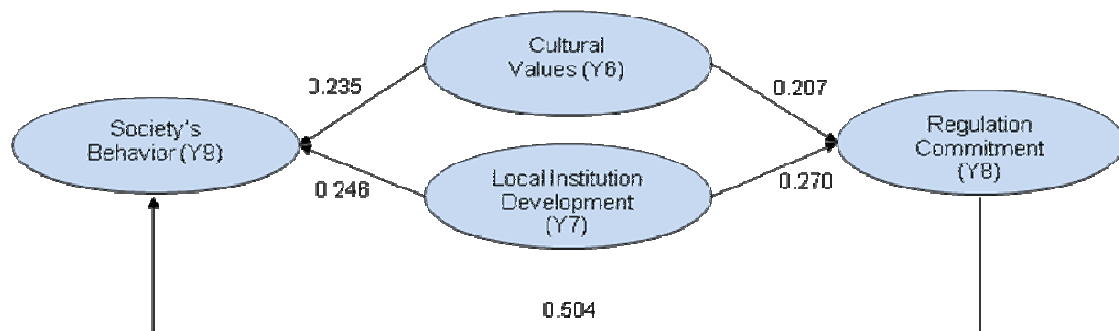
Figure 6. Direct correlation between indicator variables

4.7.2 Indirect correlation

Indirect influence of Economic Capability towards Regulation Commitment and Society's Behavior are significant through Cultural Values (r= 0.056 and r= 0.064 respectively). This means, if the economic capability value is high, the value of the Regulatory Commitment and Society Behavior will be high too, as well as the value of Cultural Value.

Educational Perspectives and Social Environment are indirectly correlated to Society's Behavior via Cultural Values (r= 0.066 and r= 0.068 respectively). This means, if the value of educational perspective and social environment is high, the value of Society Behavior is high too, as well as the value of Cultural Value. These indirect correlations among indicator variables showed in Figure 7.
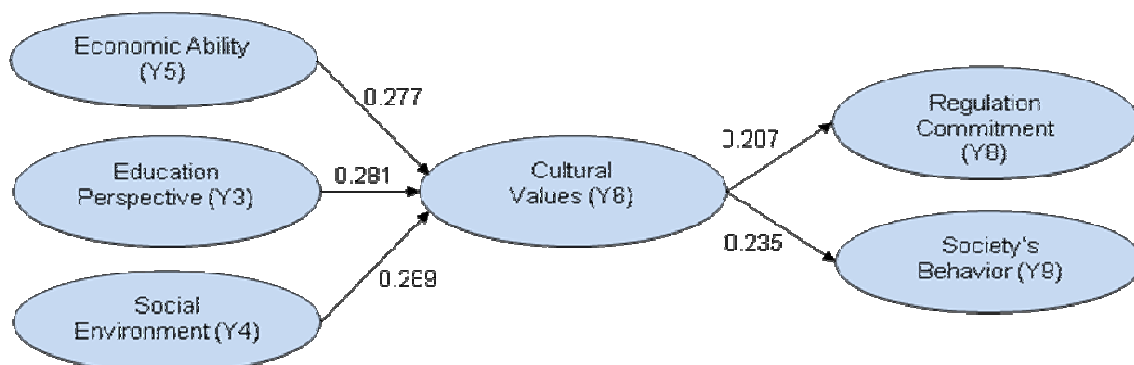

Figure 7. Indirect correlation between indicator variables

4.8 Discussion

From the analysis result, it mean that the policy of Jakarta Government – to prevent society residence around the Ciliwung riverbank to not polluting the water – will not provide optimal results if it's just providing appropriate jurisdiction sanctions according to the regulations. The results of this study indicate that there are various factors that influence the society behavior who live on Ciliwung river banks, either direct influence or indirect influence. So, they need comprehensive and integrative policies, and also synergy for: (1) educational perspective and response of change; (2) social environment; (3) the economic capability; (4) development of local institutions; (5) cultural values; and (6) compliance commitment of citizens to the regulation.

The policy of course need to be accompanied with the policies toward other factors that have been investigated by previous studies, as well as other variables that might become consideration for further researchers. If with these policies the behavior of riverbanks societies can be awakened positively, concrete and participatory, it will have a positive impact on the water quality of the river Ciliwung.

5. Conclusion

The change of Ciliwung river conditions has been occurred due to the human behavior, which decreasing quality of water. Increasing the number of people and people behavior who live on the banks of Ciliwung has added the

domestic waste which causes severe pollution of the river. Ciliwung pollution as the result of domestic waste has been represented on the laboratory testing.

The results of statistical tests on the effects of driving factors and pull factors of migration, as well as preferential of live along the Ciliwung riverbank is concluded as follows:

1. The greater driving and pull factor will inflict on the higher levels of migration to live in Jakarta.

2. The higher levels of migration to live in the city, it will lead to higher of reidential preference on Ciliwung riverbanks.

The analysis on the society behavior that lives on the banks of Ciliwung river riverbank is concluded as follows:

1. The better educational perspective, aspects of the social environment and economic capability will result on the higher of cultural values in environmental conservation.

2. The better educational perspective, aspects of the social environment and economic capability will lead to the higher efficacy on the development of local institutions.

3. The better indicator variables – educational perspective, aspects of the social environment, economic capability and the higher cultural values and success of development of the local institutions – will result higher adherence of community's commitment to the environmental regulations.

4. The better perspective of education, aspects of the social environment and economic capability, through the medium of high cultural values, institutional development, and the compliance commitment of the local residents on the regulation, indirectly will result in the higher positive attitude of society towards the environment.

It can be concluded further that the behavior of society on the banks of the Ciliwung river does not support the preservation of river function yet, even it increases the level of water pollution that inhibits the function of the river. That means, the prevention efforts of pollution in the Ciliwung River, particularly in the area ofresearch, does not able to utilize the concrete-positive participation of the society.

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