Index Risk of Sanitation (IRS) Modeling to Determine Domestic Waste Water System

Florianus Rooslan Edy Santosa\textsuperscript{1*}, Arief Dwi Atmoko\textsuperscript{2}, Bustomi Arifin\textsuperscript{3}

\textsuperscript{1}Narotama University, Department of Civil Engineering, Surabaya, Jawa Timur 60117, Indonesia
\textsuperscript{2}Narotama University, Department of Law, Surabaya, Jawa Timur 60117, Indonesia Program Study of Law, Faculty of Law – Narotama University
\textsuperscript{3}Narotama University, Department of Education and Science, Surabaya, Jawa Timur 60117, Indonesia

\textsuperscript{*}eddy.santosa@narotama.ac.id

Abstract. Indonesian government through National Medium Development Term Plan (2015 - 2019) aims 100% easy access of clean and fresh drink water, and 100% decent access of sanitation. The present study aims to determine index risk of sanitation modeling (IRS) of domestic waste water as an effort in achieving the target of Universal Access 2020. Discriminants that resulted from the present study are: $Z_1 = -41.86 - (1.16 \times \text{IRS}) + (0.07 \times \text{PM}) + (0.16 \times \text{PP}) + (0.11 \times \text{PWM})$ dan $Z_2 = 6.74 - (1.54 \times \text{IRS}) + (0.01 \times \text{PM}) + (0.21 \times \text{PP}) - (0.26 \times \text{PWM})$ in which it is used to determine domestic waste water system. Variables that influence this system are index risk of sanitation (IRS), female participant (PP), poor people (PWM), and beneficiary (PM). When the equation mentioned above is applied into 154 districts in Surabaya, the result will be as follow: 1) Based on Domestic Waste Water System there are 57 districts (37,01%) that can be included into communal system, 31 (20,13%) districts are included into domestic IPAL system and 66 districts (42,86%) are included into combination between communal and IPAL system.

1. Introduction
Development of significance sanitation system in developing countries is able to increase numerous aspects such as health, social, and economics \cite{1}. Sanitation becomes challenging issue for developing country like Indonesia. Sanitation issues can be categorized in numerous factors such as the area whether city or suburb, clean water supply, disposal of fecal matter, and waste system \cite{2}. That disposal of waste is determined by the household based on the regulation \cite{3}-\cite{4}. Household waste systems that mentioned above such as on-site system for instance VIP toilet, closet, ecological toilet sanitation\cite{5}-\cite{6} or off-site system such as condominial disposal \cite{7}\cite{8}-\cite{9}. Domestic waste water that are resulted will be processed into several processes to create added value although at the end it will be disposed into final disposal place (TPA)\cite{10}.
The establishment of sanitation profile area is an effort to achieve the target of Universal Access 2019. Through this profile, sanitation risk can be detected and it can be used as guidance in determining domestic waste water system in order to achieve 100% clean water coupled with sanitation facility that are aimed in 2020.

Sanitation is a multi step process in managing various waste from waste source to reusing point or final process. Sanitation system and clean water that implemented in suburb and city areas are different. Suburb area is using simple approach in term of technology and social aspects. Moreover, suburb area need sustainable supervision and monitoring to educate society about the importance of sanitation in regard to their health [11]. Meanwhile, city area is using sophisticated approach in form of technology and social aspects. This area need to concern about budgeting aspect since this area mainly divided into 2 residential which are legal coupled with illegal residential. The existence of these settlements are influencing economics condition of the society. Domestic waste water system using centralized system means managing collecting system, management process and final process of high volume waste [12]-[13]. According to its construction, centralized waste system is suitable to be applied in small area of settlement in the city mainly for low and medium economics society [14]-[15].

Indonesian National Action Plan targeted around 89.35% sanitation access for the city meanwhile 62.94% sanitation access for suburb area. Development of sanitation in Indonesia becomes national and regional priority. It can be seen clearly on the goals of Indonesian National Medium Development Term Plan (RPJMN). Study in 2011 about risk area mapping of environmental health in Surabaya show that there are 18% regarded as high risk area, 22% regarded as medium risk area, 45% regarded as low risk area and 14% regarded as clean area [16]. Further study show that 9 districts or 5.84% are regarded as less risk area (index 1), 67 districts or 43.51% are regarded as medium risk area (index 2), 61 districts or 39.61% are regarded as high risk area (index 3), and 17 districts or 11.04% are regarded as very high risk area [17].

2. Research Methods
2.1. Primary, Secondary and Observation
Primary data is collected from field study through the analysis of Index Risk of Sanitation (IRS), secondary data is collected through numerous data such as population density, access of clean water, access of latrine, and number of poor families, meanwhile the present method also supported by observation through field trip and perception of working group concerning sanitation in Surabaya.

2.2. IRS Mapping Stages
Mapping of risk area in Surabaya was conducted in order to gain accurate data of IRS in which it is clustered into four classifications. Determination of the present classifications are based on addition of various values which are: analysis of IRS as primary data, analysis of secondary data, field trip report, and working group perception concerning sanitation in Surabaya.

2.3. IRS Modeling to Determine Domestic Waste Water System
IRS modeling stages to determine domestic waste water system can be seen as follow:
1. Analysis of IRS in Surabaya in form of clustered area into four classifications,
2. Classifications result will be used as reference in determining domestic waste water system in Surabaya which are: Communal toilet, IPAL communal and combination between communal toilet coupled with IPAL communal,
3. Analysis of relation between IRS and domestic waste water system; IRS coupled with its sustainability; domestic waste water system and its sustainability by utilizing analysis of discriminant,
4. Formulating the relation between IRS and domestic waste water system; IRS and its sustainability; domestic waste water system and its sustainability as recommendation model of proper domestic waste water system in Surabaya.
3. Result and Discussion
Analysis of discriminant for determining domestic waste water system is conducted to choose variable that can be included as model and independent variable that influence in clustering domestic waste water system. Analysis result of domestic waste water system can be seen in the table mentioned below:

Table 1. Result of Independent Variable Test in Clustering Domestic Waste Water System

| Sustainable Factors                        | Wilks' Lambda | F     | df1 | df2 | Sig. |
|--------------------------------------------|---------------|-------|-----|-----|------|
| Index Risk of Sanitation (IRS)             | 0.32          | 39.12 | 2   | 37  | 0    |
| River Flow Area (DAS)                      | 0.94          | 1.18  | 2   | 37  | 0.32 |
| Population Density (KP)                    | 0.97          | 0.47  | 2   | 37  | 0.63 |
| Business Area (KBP)                        | 0.97          | 0.42  | 2   | 37  | 0.66 |
| Beneficiary (PM)                           | 0.09          | 175.18| 2   | 37  | 0    |
| Female Participatory (PP)                  | 0.08          | 204.50| 2   | 37  | 0    |
| Poor People as Beneficiary (PWM)           | 0.09          | 179.10| 2   | 37  | 0    |
| Cost Analysis (AB)                         | 0.98          | 0.301 | 2   | 37  | 0.74 |

Table 1 shows that there are 4 independent variables that are significantly different which are Index Risk of Sanitation Risiko Sanitasi (IRS), Beneficiary (PM), Female Participatory, and Poor People as Beneficiary in which Sig value of those variables are 0.000 (less than 0.05). It means determination of domestic waste water system can be based on 3 options which are 1 (Communal Toilet), 2 (IPAL Communal System), and 3 (Combination of Communal Toilet and IPAL Communal System) in which those option are influenced by 4 independent variables that are scored less than 0.05.

After knowing variables that passed the test, discriminant function can be determined based on 4 variables that passed the test and possessed strong correlation. Coefficient for each discriminant function will be portrayed in table 2 below.

Table 2. Coefficient Determiner of Discriminant Function 1 and 2

| Sustainable Factors Support: Domestic Waste Water System | Function 1 | Function 2 |
|---------------------------------------------------------|------------|------------|
| Index Risk of Sanitation (IRS)                          | -1.16      | 1.54       |
| Beneficiary (PM)                                        | 0.07       | 0.01       |
| Female Participatory (PP)                               | 0.20       | 0.21       |
| Poor People as Beneficiary (PWM)                        | 0.11       | -0.26      |
| (Constant)                                              | -41.86     | 6.74       |

Unstandardized coefficients

Based on the discriminant code IRS means Index Risk of Sanitation, PM means beneficiary, PP means female participatory, and PWM means poor people as beneficiary in each district. Discriminant equations from table 2 are as follow: Discriminant Function 1: \[ Z1 = -41.86 - (1.16*IRS) + (0.07*PM) + (0.16*PP) + (0.11*PWM) \] and Discriminant Function 2: \[ Z2 = 6.74 + (1.54*IRS) + (0.01*PM) + (0.21*PP) - (0.26*PWM) \]. Z1 means discriminant function 1 (axis x) meanwhile discriminant function 2 (axis Y). Axis X and Y are absica and ordinate from Territorial Map that determine district can be included into domestic waste water using communal, IPAL or combination between communal and IPAL.

Discriminant equation mentioned above when applied into Territorial Map toward all districts in Surabaya which consist of 154 districts, the result will be as follow: there are 60 districts (39%) that can be included into domestic waste water using communal system, 30 districts (19%) can be included
into domestic waste water using IPAL system, and 64 districts (42%) can be included into combination system of communal and IPAL. Further more, visualization of Territory Map of Domestic waste Water System in Surabaya can be seen below.

![Territorial Map of Domestic Waste Water System in Surabaya](image)

**Figure 1. Map of Surabaya Domestic Waste Water System**

4. **Conclusion**

Based on result of the research mentioned above, it can be concluded that:

1. Variables that influence determination of domestic waste water system in Surabaya are: Index Risk of Sanitation (IRS), female participatory (PP), Poor People as Beneficiary (PWM), and Beneficiary (PM).
2. Discriminant equation mentioned above when applied into Territory Map toward all districts in Surabaya which consist of 154 districts, the result will be as follow: there are 60 districts (39%) that can be included into domestic waste water using communal system, 30 districts (19%) can be included into domestic waste water using IPAL system, and 64 districts (42%) can be included into combination system of communal and IPAL.

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