JEN Vol. 04 No. 01, April 2019
P. ISSN 2527-9629
E. ISSN 2548-6675

JOURNAL OF ENVIRONMENTAL ENGINEERING & WASTE MANAGEMENT

JENV	Vol. 04	No. 01	Page 1-42	April 2019	P. ISSN 2527-9629 E. ISSN 2548-6675

JOURNAL OF ENVIRONMENTAL ENGINEERING & WASTE MANAGEMENT
JURNAL TEKNIK LINGKUNGAN DAN PENGELOLAAN LIMBAH

Ketua Editor
Ir. Temmy Wikaningrum, M.Si.

Dewan Editor

Prof. Dr.-Ing. Ir. Suprihatin	Institut Pertanian Bogor
Dr. Ir. Yunita Ismail, M.Si.	Universitas Presiden
Ir. Ramadhani Yanidar, M.T.	Universitas Trisakti
Dr. Ani Mulyasuryani, MS	Universitas Brawijaya
Dr.Yusmaniar, M.Si.	Universitas Negeri Jakarta
Dr. Astri Rinanti Nugroho, M.T.	Universitas Trisakti
Ir. Eddy Setiadi Soedjono, Dipl.S.E., M.Sc., Ph.D.	Institut Teknologi Sepuluh November
Dr. Muhammad S. Ahmadin	Sullivan University Kentucky
Ir. R. Driejana, M.SCE, Ph.D.	Institut Teknologi Bandung
Maryani P. Astuti, S.T. M.Sc.	University of Auckland

Editor Pelaksana

Rijal Hakiki, S.S.T., M.T.	Universitas Presiden
Filson M. Sidjabat, S.T., M.T.	Universitas Presiden
Yandes Panelin, S.T., M.T.	Universitas Presiden
Sukino, S.I.P.	Universitas Presiden

Alamat Redaksi

Journal of Environmental Engineering & Waste Management
Jurnal Teknik Lingkungan dan Pengelolaan Limbah

Building A Lt. 3 President University
Jl. Ki Hajar Dewantara, Jababeka Education Park, Cikarang Baru, Bekasi 17550 – Indonesia
Phone./Fax: (021) 8910 9762 / 9768; Email: j-env@president.ac.id
Website: env.president.ac.id (President University: www.president.ac.id)

JENV adalah jurnal yang mengkaji berbagai masalah/persoalan terkini yang bersifat mendasar atau terapan yang berhubungan dengan bidang teknik dan pengelolaan lingkungan serta pengelolaan limbah dengan frekuensi penerbitan dua kali setahun pada April dan Oktober. Kelayakan pemuatan dipertimbangkan oleh penilai dengan *double blind review* berdasarkan keaslian dan keabsahan ilmiah.

JOURNAL OF ENVIRONMENTAL ENGINEERING & WASTE MANAGEMENT
JURNAL TEKNIK LINGKUNGAN DAN PENGELOLAAN LIMBAH

Volume 4, No.1, April 2019

EDITORIAL

Pembaca yang terhormat, Jurnal Teknik Lingkungan dan Pengelolaan Limbah (JENV) yang terbit bulan April 2019 ini merupakan jurnal edisi ketujuh yang diterbitkan oleh Universitas Presiden. Dengan tujuan untuk berkontribusi secara nyata di bidang Teknik Lingkungan berdasarkan ilmu pengetahuan, manajemen dan teknologi yang terkini, kehadiran jurnal ini diharapkan mampu memberikan inspirasi terhadap solusi masalah-masalah lingkungan yang semakin memerlukan perhatian yang memadai.

Pada edisi ketujuh Jurnal JENV ini terdapat satu makalah mengenai analisis jumlah pencemar dalam air dan air limbah: *Making and Testing Sample Control on Determination of Nitrite Content in Water and Wastewater Using UV-Visible Spectrophotometer*; satu makalah mengenai pemodelan *green supplier*: Pengembangan Model Pemilihan Green Supplier di Kawasan Industri Cikarang; satu makalah mengenai pemanfaatan limbah: Pemanfaatan Limbah Organik Berbasis Bio Cyclo Farming (Studi Kasus Desa Telaga Murni); satu makalah mengenai uapaya keberlanjutan: *The Academic Community Perception About Implementation of UI GreenMetric-Waste Management Criteria at President University*; serta satu makalah mengenai pengelolaan limbah: *Comparison Study of BOD & COD of Leachate Quality (Case Study in Air Dingin Landfill and Jatibarang Landfill*.

Semua tulisan ilmiah yang dipublikasikan telah melalui proses seleksi dengan metoda *double blind* oleh dewan redaksi dan mitra bestari.

Pada kesempatan ini kami mengucapkan terimakasih kepada dewan pengarah, dewan redaksi, editor pelaksana, tim sekretariat, dan para penulis yang telah memberikan peran secara aktif sehingga penerbitan Jurnal JENV ini dapat terlaksana dengan baik. Kami berharap Jurnal JENV volume 4 nomor 1 bulan April 2019 ini dapat bermanfaat bagi perkembangan ilmu dan pendidikan di Indonesia, khususnya di bidang Lingkungan Hidup.

Ketua Dewan Editor

MAKING AND TESTING SAMPLE CONTROL ON DETERMINATION OF NITRITE CONTENT IN WATER AND WASTE WATER BY USING UV-VISIBLE SPECTROPHOTOMETER

Erna Styani[1], Endang Sri Lestari[2], Ika Widiana[3] and Muhammad Ramadhan[4]
Polytechnic of AKA Bogor, Industrial Human Resources Development Board
Ministry of Industri Republic of Indonesia
Jl Pangeranan Sogiri 283 Tanah Baru, Bogor, West Java, Indonesia
[1]ernasekarboedhi17@gmail.com, [2]lestarirahadiian@ymail.com, [3]widiana.ika@gmail.com, and
[4]ramadhanm9650@gmail.com

Abstract: This study focused on Making and Testing sample control as reference material on determination of nitrite content in water and waste water by using UV-Visible Spectrophotometer. Sample control has been made to replaced Certified Reference Materials (CRM) for determination of Nitrite content in water and waste water by using UV -Visible Spectrophotometer. Substitute materials for CRM should be homogeneous and stable, so the homogenity and stability control sample that has been made in this study is tested by using standard referring to ISO Guide 35 , 2006. The result of this experiments shows that the values of F_{stat} and F_{table} on homogenity test are 0.796 and 3.179 ($F_{stat} < F_{table}$); while the values of t_{stat} and table on the stability test are 0.431 and 2.101 ($t_{stat} <$ table), the mean of control sample concentration is 0,0435 mg / L. All test parameters have been qualified in accordance with ISO Guide 35 , 2006. The result of this research shows that the control of samples on the determination of Nitrite in water and waste water by using UV-Visible Spectrophotometer can be used as substitute for CRM and reference material.

Keywords: *sample control, Nitrite content, UV-Visible Spectrophotometer, Certified Reference Materials*

Abstrak: *Penelitian ini berfokus kepada pembuatan dan pengujian kontrol sample sebagai pengganti material dalam penentuan kadar kandungan nitrit di dalam air dan air limbah menggunakan UV-Visible Spectrofotometer. Kontrol sampel telah dibuat untuk menggantikan Certified Reference Materials (CRM) pada penentuan kandungan Nitrit dalam air dan air limbah dengan menggunakan Spektrofotometer Sinar Tampak. Homogenitas dan stabilitas kontrol sampel yang telah dibuat diuji dengan menggunakan standar yang mengacu pada ISO Guide 35, 2006. Hasil percobaan ini menunjukkan bahwa nilai F_{stat} dan F_{table} pada uji homogenitas adalah 0,796 dan 3,179 ($F_{stat} < F_{tabel}$); sedangkan nilai tstat dan ttabel pada uji stabilitas adalah 0,431 dan 2,101 ($t_{sta}t < t_{tabel}$), rata-rata konsentrasi sampel kontrol adalah 0,0435 mg / L. Semua parameter uji telah memenuhi syarat sesuai dengan ISO Guide 35, 2006. Hasil penelitian ini menunjukkan bahwa kontrol sampel pada penentuan Nitrit dalam air dan air limbah dengan menggunakan Spektrofotometer Sinar Tampak dapat digunakan sebagai pengganti CRM dan bahan acuan.*

Kata Kunci: *kontrol sampel, kandungan Nitrit, Spektrofotometer Sinar Tampak, Bahan Referensi Bersertifikat*

INTRODUCTION

The accuracy test data was proved by the standard deviation value of the repetition results of an analysis, whereas for the accuracy of laboratory data must have reference materials, such as Certified Reference Materials (CRM). The reference material is one or more quantitative values known with certainty the content (in the form of true value or assigned value) is contained in the form of certificate.

The price of the certified reference material is relatively expensive, so the laboratory is not always possible to use CRM for daily analysis in proving the accuracy of the data, so that the sample control as an alternative substitute of reference material was used. Sample control is a reference material made by a laboratory used as a monitor of routine measurement analysis quality.

Several studies related to CRM have been carried out such as "Value Determination of Geochemical In-House Reference Material with Andesite Matrices from Hargorejo Kulon Progo" (Irzon, 2018) and Analysis Methods for Development of Certified Reference Material (CRM) Zircon Minerals Synthesis (Samin and Sunanti, 2018).

This experiment purposes was to create and tested samples control that had

been made to be used as a substitute of reference or CRM on the determination of nitrite levels in water and waste water by UV-Vis Spectrophotometry (Gandjar, 2007). Replacement of the reference material should be homogeneous and stable, so that the homogenity and stability of the sample control shall be tested in accordance with ISO Guide 35 of 2006 (Taylor, 1996).

MATERIAL AND METHODS

The experiment consists of three stages: preparation, testing, and data processing. Preparation consists of preparation of nitrite sample control 0,05 mg/L, making nitrite stock solution 250 mg/L, making of nitrite standard solution 0,50 mg/L, making of nitrite stock solution 100 mg/L, making of color reagent, and making of series nitrite standard.

The step of Making sample control can be seen in Figure 1. as bellow.

Step 1

The Surface water was filtered (initial nitrite content of 0.009 mg/L) and then loaded into empty and clean container

Step 2

Added with 100 ppm stock solution and homogenized

Step 3

Disposable PE Bottle was prepared and labelled

Step 4

Homogenized solution was inserted into PE Bottle

Step 5

Sample Control (0,05 mg/L) kept in refrigerator.

Figure 1. The Step of Making Sample Control

The sample control solution that has been made above (Figure 1), then determined the nitrite content by pipeting 50 mL solution then put into 50 mL volumetric flask, added 2 mL of color reagent , shaking it and leaving it for about 10 minutes to two hours and the absorbance is measure at a wavelength of 543 nm. The coloring reagents used in nitrite content determination can be made by added 50 mL 85% phosphoric acid and 5 g sulfanilamide into 400 mL distilled water. After sulfanilamide is completely dissolved, 500 mg N-(1-naphthyl) ethylene diamine dihydrochloride (NED) is added, stirred until dissolved, then adjusted to 500 mL with distilled water. The solution store in dark bottle and in the refrigerator. (SNI 06-6989.9-2004).

The testing stage is done by determining the control level of nitrite sample (homogenity, true value, and stability). Phase data processing of the test results done statistically and displayed in the control chart.

The homogenity test had done once in each process of controlling the nitrite sample, and performed simultaneously with the first test of stability. Tests were performed with ten packaged samples randomly to be tested. The true value test was done just like the homogenity test

done in different time. Testing on each packing was done twice repetition (duplo).

Stability testing as the first data used data analytical content of homogenity test results, then the next data was tested once a week. Tests were performed with ten packaged samples randomly to be tested. Testing on each packing was done by twice repetition (ISO Guide 35, 2006).

The method of sampling test refers to ISO 13528 in 2005 on Statistical Methods for Use in Proficiency Testing by Interlaboratory Comparisons. The sampling scheme for the determination of nitrite sample control (homogenity, true value, and stability) can be seen in Figure 2.

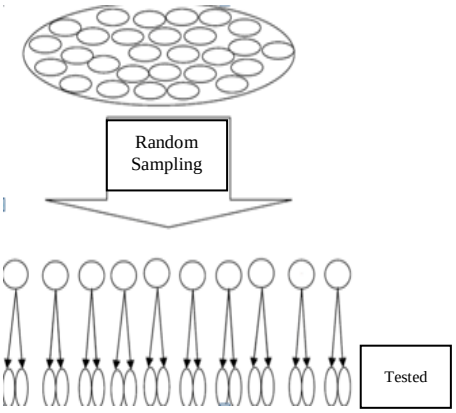


Figure 2. The Scheme of Sampling for Nitrite Sample Control Test

The homogenity of the sample is determined statistically. Based on the National Accreditation Committee, there are four criteria of homogenity, they are:

a) $F_{stat} < F_{table}$
b) $\frac{S_{sampling}}{\sigma} < 0{,}3$
c) $S_{sampling} < 0{,}3\ S_{horwitz}$
d) $S_{sampling} < S_{horwitz}$

If the result of homogenity test of criterion I is fulfilled, then it is not necessary to process the data on the next criteria (Komite Akreditasi Nasional, 2004).

The stability of the sample is known by the difference between the mean homogenity ("x"¯_ "homogenity") and the stability ("x"¯_ "stability") of t count that compared with t table. Samples can be said to be stable if they meet the requirements, i.e:

$$t_{stat} = \frac{|\ \bar{x}_H - \bar{x}_S\ |}{SD} \times \sqrt{\frac{(\ n_H \times n_S\ )}{(\ n_H + n_S\ )}}$$

The True Value is determined by calculating the average of the test result (true value), then compared with the target value with the acceptability of (100 ± 15)%.

The control chart is a graphical display by comparing the results data on continual process to a stable and predetermined control limits of the previous performance data. Sudijono (2010) explained that control limits on the control chart consists of :

a) Upper control limit (UCL) ($\bar{x}$ + 3SD)
b) Upper warning limit (UWL) ($\bar{x}$ + 2SD)
c) Lower warning limit (LWL) ($\bar{x}$-2SD)
d) Lower control limit (LCL) ($\bar{x}$ - 3SD)

Control sample solutions that have been made can be use as substitute CRM if all test parameters were in compliance with ISO Guide 35 of 2006., with the homogenity value $F_{stat} < F_{table}$ and the value of stability t_{stat} < table.

RESULT AND DISCUSSION

Nitrite levels in surface water were determined using UV-Vis Spectrophotometry (Effendi, 2003). Nitrite compounds in surface water are usually found in very small amounts in the water over nitrate, because nitrites are unstable in the presence of oxygen, which will immediately be oxidized become nitrate (Achmad, 2004).

Each analysis performed requires a calibration curve to prove the existence of a linear relationship between the concentration and the response of the device. The calibration curve shows the ability of the analysis method to produce a response proportional to the concentration of the analyte in the sample in the range or range that exists (Hadi, 2007). The

calibration curve is obtained from the relationship between concentration value and the tool response. Results The calibration curve on the determination of nitrite in water and wastewater can be seen in Fig 3.

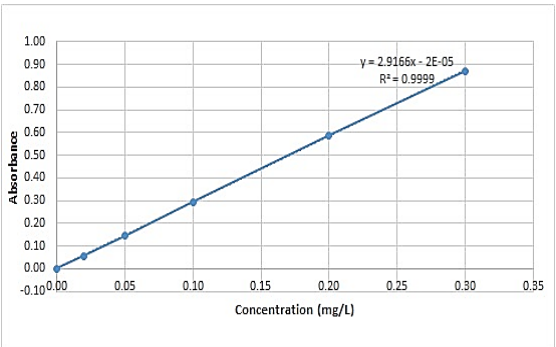


Figure 4. Calibration Curve of Nitrite Determination in Water and Wastewater

As the regression line that showed from figure 4, the obtained correlation value was 0.9999. The test results proved that there was a linear relationship between the method with the tool response and qualify acceptance of correlation, that was r $\geq$ 0.9950. Based on the nitrite determination calibration curve, the obtained slope value was 2.9166 and the intercept value was -0.00002, so that the equation obtained by regression line was y = -0,00002 + 2,9166x.

In the experimental process and testing of sample control on the determination of nitrite in water and wastewater by UV-Spectrophotometer light was tested to the test material to find out the requirements that fulfilled as quality qontrol on sample control. The tests conducted were: homogenity, stability, and true value (Sudijono, 2010).

Homogenity test is a test that aims to know the dissemination of analyte in the sample before being used in the test. The spread of the analyte evenly on the reference material is very important, since the non-homogeneous reference material will yield mixed results and has no true value. Homogenity test was done by comparing the variety of two data, commonly called the F test. The homogenity test results can be seen in Table 1.

According to the homogenity test results which is shown on Table 1, the obtained Fcount value is 0.80 and the Ftable of 3.18 has 95% confidence level. Meanwhile, according to the experimental obtained value, the sample control meets the criterion I, that is Fcount is less than the Ftable value, so the material can be said homogeneous. The results of the experiments also showed that the dissemination of the analyte in the test material was evenly distributed throughout the sample so that further analysis can be performed.

Stability test is a test that aims to determine the effect of time on the concentration of analyte in a test material. The stability test had an important role in testing the control of the sample, because it showed that the analytical concentration did not change significantly if it was stored for long periods of time. This was to ensure the quality of the control samples that have been made. The stability test was calculated statistically by comparing two independent data sets which called t tests. The results of stability testing can be seen in Table 2.

According to the results of stability test in Table 2, the obtained tcount value is 0.431 and table value is 2.101 with 95% confidence level. Based on the test value, the test material has met the stipulated requirements, that is the value of tcount is smaller than the table value.

Table 1. Homogenity Test Result

Sample Number	Repetition		Acceptance Requirements
	NO_2 (mg/L)	NO_2 (mg/L)	
1	0.0432	0.0436	$F_{stat} < F_{table}$
2	0.0436	0.0439	
3	0.0436	0.0432	
4	0.0432	0.0432	
5	0.0432	0.0436	
6	0.0436	0.0432	
7	0.0436	0.0436	
8	0.0432	0.0432	
9	0.0442	0.0432	
10	0.0436	0.0432	
Mean Square Between	6.60×10^{-8}		
Mean Square Within	8.29×10^{-8}		
F_{stat}	0.80		
F_{table}	3.18		

The t-test material values which smaller than the table indicated that the analyte concentration on the reference material had not changed significantly for two months of storage and was stable.

The true value test is a series of tests to ascertain the true value of analytical concentrations contained in the test material. In the conducted experiments, the measured initial nitrite content of the test material (surface water) then was known to have of 0.009 mg / L. The test material was added with a 100 mg / L nitrite parent solution to obtain a level of 0.050 mg / L. The true value test results can be seen in Table 3.

Table 2. Stability and Homogenity Test Result

Week	Mean Stability (mg/L)	Mean Homogenity (mg/L)	Acceptance Requirement
1	0.0437	0.0434	$T_{stat} <$ table
2	0.0434	0.0437	
3	0.0436	0.0434	
4	0.0437	0.0432	
5	0.0437	0.0434	
6	0.0437	0.0434	
7	0.0436	0.0436	
8	0.0436	0.0432	
9	0.0439	0.0437	
10	0.0432	0.0434	
Mean	0.0436	0.0434	
SD	0.0002	0.0002	
t_{stat}	0.431		
t_{tabel}	2.101		

Based on the test results in Table 3, the actual values of the test materials had been added by 100 mg / L main nitrite solution of 0.0435 mg / L. Then the obtained value did not reach the desired target value (0.050 mg / L), due to a systematic error in adding aquadest solution slight excessively, but this did not affect the quality of the test material to serve as a sample control.

Table 3. True Value Test Result

Sample	True Value (mg/L)		
	Repetition 1	Repetition 2	Mean
1	0.0432	0.0439	0.0436
2	0.0436	0.0432	0.0434
3	0.0439	0.0439	0.0439
4	0.0432	0.0436	0.0434
5	0.0432	0.0439	0.0436
6	0.0432	0.0439	0.0436
7	0.0436	0.0436	0.0436
8	0.0439	0.0436	0.0437
9	0.0432	0.0432	0.0432
10	0.0439	0.0442	0.0441
Mean			**0.0435**

The actual values of the test materials had been added by 100 mg/L nitrite stock solution was 0.0435 mg/L. The obtained value did not reach the desired target value (0.0500 mg/L), due to a systematic error in adding aquadest solution slight excessively, but this did not affect the quality of the test material to serve as a sample control.

Table 4. Measurement Result and Acceptance Requirement

Parameter	Description	Test Value	Requirement
Homogenity	F_{stat}	0.796	$F_{stat} < F_{table}$
	F_{table}	3.179	
Stability	t_{stat}	0.431	$t_{stat} <$ table
	table	2.101	
True value	True Value	0.0435 mg/L	–
	Target Value	0.0500 mg/L	

The control chart (control chart) is a statistical method to monitor the test results. This monitoring was carried out from monitoring of tools, methods, and analysts during ongoing testing. A control chart is a graphic display which compared the data that generated by the current process to a stable set of control limits that have been determined from the previous performance data. Results of the control chart data can be seen in Figure 5.

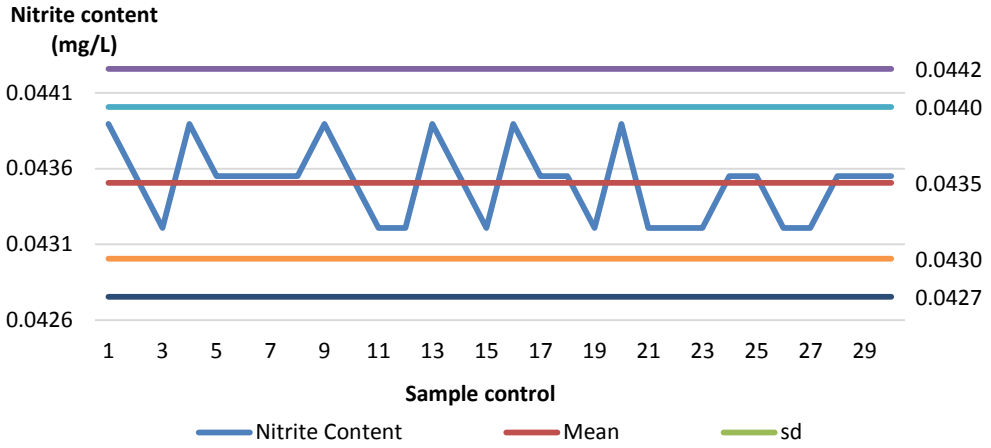


Figure 5. Control Chart of Nitrite Sample Control

According to Figure 5, the mean of the control test sample was 0.0435 mg / L, UCL of 0.04426 mg / L and LCL of 0.0428 mg / L which were the upper and lower control limits. In addition, the UWL value was 0.04423 mg / L and LWL was 0.0430 mg / L which were the upper and lower warning limit.

The control chart data does not exceed the control limits or warning limits, so it can be said that the tests were under controlled conditions and no deviations were found that could interfere the analysis process.

CONCLUSION

According to the experiments that had been done, the obtained result were Fstat and Ftable value on homogenity test are 0.796 and 3.179 ($F_{stat} < F_{table}$). Furthermore, t_{stat} and table value on the stability test are 0.431 and 2.101 (t_{stat}< table). The mean of control sample concentration was 0,0435 mg/L. All test parameters were in compliance with ISO Guide 35 of 2006. It can be concluded that the sample control, which has been made from surface water on this study on the determination of nitrite in water and wastewater by using UV-Visible Spectrophotometer can be used as a substitute for CRM and become a reference for routine analysis.

ACKNOWLEDGEMENT

This research was supported by Polytechnic of AKA Bogor.

REFERENCE

Achmad, R. (2004). Kimia Lingkungan. Andi Offset. Yogyakarta.

Effendi, H. (2003). Telaah Kualitas Air bagi Pengelolaan Sumber Daya dan Lingkungan Perairan. Kanisius. Yogyakarta.

Gandjar, L. G. (2007). Kimia Farmasi Analisis. Pustaka Pelajar :Yogyakarta.

Hadi, A. (2007). Pemahaman dan Penerapan ISO/IEC 17025;2005 Persyaratan umum Kompetensi Laboratorium Pengujian dan Laboratorium Kalibrasi. PT Gramedia Pustaka Utama : Jakarta.

Irzon, R. (2018). Value Determination of Geochemical In-House Reference Material with Andesite Matrices from Hargorejo Kulon Progo. Retrieved May 9, 2019 from www.academia.edu

ISO 13528. (2005). Statistical Methods for Use in Proficiency Testing by Interlaboratory Comparisons.

ISO GUIDE 35. (2006). Reference Material.

KOMITE AKREDITASI NASIONAL. (2004). Pedoman Perhitungan Statistik untuk Uji Profisiensi. Jakarta.

Samin., Susanti, S. T. (2018). Analysis Methods for Development of Certified Reference Material (CRM) Zircon Minerals Synthesis. *Indones. J. Chem*, 18(8), pp 448-456.

SNI 06-6989.9-2004 (2004). Air dan Air Limbah-Bagian 9 : Cara Uji nitrit (NO_2-N) secara spektrofotometri

Sudijono, A. (2010). Pengantar Statistik Pendidikan. PT Raja Grafindo Persada: Jakarta

Taylor, J. K. (1996). Quality Assurance of Chemical Measurement. Center of Analytical Chemistry. New York.

PENGEMBANGAN MODEL PEMILIHAN *GREEN SUPPLIER* DI KAWASAN INDUSTRI CIKARANG

Filson Maratur Sidjabat[1] dan Johan Krisnanto Runtuk[2]
[1]Environmental Engineering, [2]Industrial Engineering, President University
Jl. Ki Hajar Dewantara, Jababeka Education Park, Cikarang, Jawa Barat 17550
[1]fmsidjabat@president.ac.id,[2]johan.runtuk@president.ac.id

Abstract: Nowadays, innovation and improvement in the industrial and logistic sector are significantly increasing sustainability issues and awareness. The concept of green supply chain focuses on the supply chain management that aims to reduce the environmental impacts, increasing the natural and ecological efficiency. The companies that are willing to accelerate their environmental performances will enhance competitive advantage that will bring income and market share enhancement, also a more positive corporate image. From the literature study, several green supplier criteria were identified and then be selected and categorized by interviewing the experts. From those results, ten criteria been developed in the model by using MCDM (Multi Criteria Decision Making) methods, which are DEMATEL (Decision Making Trial and Evaluation Laboratory) and ANP (Analytic Network Process). There are five respondents as experts in the environmental engineering field and industrial estate management, who know best the condition in Cikarang Industrial Estate. Five top criteria that have the highest weight number are Environmental management system (EMS), PROPER assessment from KLHK Indonesia (PROPER), Pollution prevention and control (PLC), Energy management/efficiency (EM), and Green design or R&D (GD).

Keywords: *Supply Chain, Cikarang Industrial Estate, DEMATEL, ANP, Green Supplier Criteria*

Abstrak: Dalam perkembangan industri dan sektor logistik, terjadi kenaikan yang signifikan akan kesadaran terhadap isu *sustainability*. Konsep dari *green supply chain* mengutamakan pengelolaan rantai pasok yang bertujuan untuk mengurangi dampak lingkungan, meningkatkan efisiensi sumber daya alam dan ekologi. Perusahaan yang meningkatkan kinerja lingkungannya akan meningkatkan keunggulan bersaing yang akan membawa pada peningkatan pendapatan, pangsa pasar dan *image* korporasi yang lebih positif. Dari studi literatur diidentifikasikan berbagai kriteria *green supplier* untuk diseleksi dan dikategorikan oleh para ahli melalui wawancara. Dari hasil tersebut terdapat sepuluh kriteria yang dikembangkan dalam model dengan menggunakan dua metode *MCDM (Multi Criteria Decision Making)*, yaitu *DEMATEL (Decision Making Trial and Evaluation Laboratory)* dan *ANP (Analytic Network Process)*. Terdapat lima responden yang merupakan ahli di bidang teknik lingkungan dan pengelolaan kawasan industri, dan mengenal dengan baik kondisi di kawasan industri Cikarang. Lima kriteria utama yang memiliki pembobotan tertinggi adalah *Environmental management system (EMS), PROPER assesment from KLHK Indonesia (PROPER), Pollution prevention and control (PLC), Energy management/ efficiency (EM),* dan *Green design or R&D (GD*).

Kata Kunci: *Supply Chain, Kawasan Industri Cikarang, DEMATEL, ANP, Kriteria Green Supplier*

PENDAHULUAN

Saat ini, terjadi kenaikan yang signifikan akan kesadaran terhadap isu *sustainability*. Secara khusus, perusahaan manufaktur semakin berusaha untuk menjaga atmosfer yang bersih dan ramah lingkungan untuk mencapai penurunan biaya produksi dan juga permasalahan lingkungan (Senthilkumaran et al., 2001). Setiap kegiatan industri harus memperhatikan keseluruhan aktivitasnya agar tidak merusak lingkungan. Diperlukan suatu sistem identifikasi potensi pencemaran lingkungan dan juga penanganan terhadap permasalahan lingkungan. Hal ini kemudian mendorong banyak perusahaan untuk menerapkan *green supply chain (GSC)*, yaitu pengelolaan *supply chain* yang bertujuan untuk mengurangi dampak lingkungan dan meningkatkan efisiensi ekologi (van Hock and Erasmus, 2000).

Beberapa penelitian yang membahas mengenai dampak lingkungan telah banyak dilakukan. Sebagai contoh, Gosalbez (2011) menggunakan pendekatan *multi-objective optimization* dalam mengatasi permasalah lingkungan. Ewertowska et al. (2016) menggunakan

pendekatan *MCDM (Multi Criteria Decision Making)* dalam menghitung efisiensi lingkungan. Lebih lanjut lagi, Ewertowska et al. (2017) mengkombinasikan metode *LCA (Life Cycle Assessment), DEA (Data Envelopment Analysis)*, dan simulasi Monte Carlo dalam menghitung dampak lingkungan.

Berdasarkan beberapa literatur terdahulu di atas, dapat dilihat bahwa penelitian yang ada cenderung melihat dampak lingkungan dari proses atau aktivitas industri. Dampak lingkungan bukan hanya dipengaruhi oleh proses saja, melainkan dari input dari proses itu sendiri. Penelitian ini bertujuan untuk melakukan pengembangan model dalam pemilihan *green supplier*. Dengan melakukan seleksi yang ketat terhadap *supplier*, maka akan memperkecil peluang adanya pencemaran lingkungan yang besar.

Penelitian ini dilaksanakan di kawasan industri di Cikarang. Kawasan industri Cikarang merupakan salah satu kawasan industri terbesar di Indonesia, bahkan di Asia Tenggara. Berdasarkan pengamatan langsung dan dari beberapa media, diketahui bahwa isu pencemaran lingkungan oleh limbah pabrik merupakan isu yang paling penting. Oleh karena itu, diperlukan adanya tindakan pencegahan, yang dapat dimulai dari seleksi dari awal terhadap kesadaran akan konsep ramah lingkungan, khususnya dalam pemilihan *supplier*. Diperlukan suatu kajian yang intensif dalam mengembangkan model pemilihan *green supplier*, yang dapat dijadikan referensi bagi perusahan-perusahaan di kawasan industri Cikarang dalam memilih *supplier*.

METODE

Metode penelitian yang ditunjukkan pada **Gambar 1** Penelitian ini dimulai dengan melakukan kajian literatur yang intensif terhadap topik-topik *sustainability*, *green supply chain*, dan pada akhirnya *green supplier*. Tahap berikutnya adalah melakukan kajian dalam menseleksi kriteria yang akan dikembangkan menjadi model pemilihan *green supplier* di kawasan industri Cikarang.

Gambar 1. Metode Penelitian

Dalam mengembangkan model, dilakukan wawancara terhadap para ahli yang berkecimpung lama dalam industri dan lingkungan. Pada penelitian awal ini, para ahli dikhususkan dari akademisi terlebih dahulu. Para ahli akan diminta untuk memberikan pendapatnya mengenai kriteria yang telah didapatkan dari hasil kajian literatur. Setelah mendapatkan konfirmasi dari para ahli, maka akan dilanjutkan dengan penyebaran kuesioner untuk merancang model pemilihan *green supplier* untuk kawasan industri Cikarang. Model akan dikembangkan melalui dua metode, yaitu metode DEMATEL dan metode ANP.

Langkah-langkah yang dalam metode DEMATEL dijelaskan sebagai berikut (Tzeng et al., 2007):

A. Dapatkan *expert's opinion* dan hitung rata-rata matriks Z

Pada langkah ini, akan melibatkan sejumlah *m expert* dan *n* faktor. Setiap *expert* akan diminta pendapatnya terhadap pengaruh antara dua faktor berdasarkan perbandingan berpasangan. Derajat pengaruh faktor *i* terhadap faktor *j* dinotasikan sebagai x_{ij}. Skor berkisar antara nilai 0 (tidak ada pengaruh), 1 (pengaruh kecil), 2 (pengaruh medium), 3

(pengaruh besar), dan 4 (pengaruh sangat besar). Untuk setiap *expert*, sebuah matriks *non-negative* dibuat sebagai $X^k = [X_{ij}^k]$, dimana *k* adalah jumlah *expert* yang berpartisipasi dalam evaluasi faktor, dengan $1 \leq k \leq m$. Jadi dengan sejumlah *m* expert, akan dibuat matriks X^1, X^2, X^3, ..., dan X^m.

Untuk mengagregasi semua penilaian dari *m expert*, matrik rata-rata Z = [Z_{ij}] dihitung dengan rumus:

$$Z_{ij} = \frac{1}{m}\sum_{i=1}^{m} x_{ij}^k. \quad (1)$$

B. Hitung *the normalized initial direct-relation* matriks *D*

The normalized initial direct-relation matriks *D* = [d_{ij}], dimana nilai setiap elemen di matriks *D* berkisar antara [0,1]. Adapun perhitungannya adalah sebagai berikut:

$$D = \lambda * Z \quad (2)$$

atau

$$[d_{ij}]_{nxn} = \lambda [Z_{ij}]_{nxn}, \quad (3)$$

dimana

$$\lambda = \text{Min}\left[\frac{1}{\max 1\leq i\leq n \sum_{j=1}^{n}|z_{ij}|}, \frac{1}{\max 1\leq i\leq n \sum_{i=1}^{n}|z_{ij}|}\right] (4)$$

Berdasarkan teori *Markov Chain*, D^m adalah pangkat dari matriks *D*, contoh D^2, D^3, ..., D^∞ yang pasti akan menghasilkan solusi konvergen pada inversi matriks, sebagai yang yang ditunjukkan pada persamaan

$$\lim_{m\to\infty} D^m = [0]_{nxn}. \quad (5)$$

C. Hitung *the total relation matrix T*

Matriks *T* menunjukkan total hubungan dari setiap pasangan dari faktor, yang didapatkan dari:

$$T = \lim_{m\to\infty}(D + D^2 + \cdots + D^m) = \sum_{m=1}^{\infty} D^i, \quad (6)$$

dimana

$$\sum_{m=1}^{\infty} D^i = D^1 + D^2 + \cdots + D^m =$$
$$D(\mathrm{I} + D^1 + D^2 + \cdots + D^{m-1}) = D(I - D)^{-1}$$
$$T = D\,(I - D)^{-1} \quad (7)$$

dimana *I* adalah suatu matriks identitas *n x n*.

D. Hitung jumlah semua baris dan jumlah semua kolom matriks *T*

Pada matriks *T*, jumlah semua baris dan jumlah semua kolom, masing-masing dinyatakan dengan vektor *r* dan vektor *c*, dimana:

$$r = [r_i]_{nx1} = \left(\sum_{j=1}^{n} t_{ij}\right)_{nx1}, \quad (8)$$

dan

$$c = [c_j]'_{1xn} = \left[\sum_{j=1}^{n} t_{ij}\right]'_{1xn}, \quad (9)$$

dimana $[c_i]'$ merupakan matriks transposisi. Nilai r_i mengindikasikan total pengaruh yang diberikan, baik langsung maupun tidak langsung, dari faktor *i* terhadap faktor lainnya. Nilai c_j mengindikasikan total pengaruh yang diterima, baik langsung maupun tidak langsung, yang dimiliki semua faktor lain terhadap faktor *j*. Jika *j* = *i*, nilai (r_i + c_i) menyatakan pengaruh total, baik yang diberikan maupun yang diterima oleh faktor *i*. Sebaliknya, nilai (r_i- c_i) menunjukkan kontribusi bersih dari faktor *i* terhadap sistem. Lebih lanjut lagi, jika (r_i- c_i) bernilai positif, maka faktor *i* adalah penyebab bersih. jika (r_i- c_i) bernilai negatif, maka faktor *i* adalah penerima bersih.

E. Tentukan nilai *threshold (α)*

Nilai *threshold (α)* dihitung dari rata-rata elemen di matriks *T* dengan rumus sebagai berikut:

$$\alpha = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}[t_{ij}]}{N} \quad (10)$$

F. Buatlah diagram *cause and effect relationship*

Diagram *cause and effect relationship* dibangun dengan memetakan semua kumpulan koordinat (r_i + c_i, r_i – c_i) untuk memvisualisasikan hubungan kompleks dan menyediakan informasi untuk menentukan faktor mana yang paling penting dan bagaimana pengaruhnya ke faktor-faktor lain. Faktor dengan nilai t_{ij} yang lebih besar dari α adalah yang terpilih untuk ditunjukkan pada diagram *cause and effect relationship*.

Metode ANP merupakan suatu perkembangan dari Metode Analytical Hierarchy Process (AHP). Metode ini membantu penyelesaian masalah yang tidak pasti dan kompleks, khususnya terkait ketergantungan hubungan antar elemennya. Saaty (1999) menjelaskan bahwa metode ANP mampu mengakomodasi adanya keterkaitan antar elemen, yaitu keterkaitan di dalam satu set elemen (*inner dependence*) dan keterkaitan antara elemen yang berbeda (*outer dependence*). Adanya *inner dependence* dan *outer dependence* antar elemen pada metode ANP akan menghasilkan suatu hasil yang lebih baik, yang akan digunakan dalam pengambilan keputusan.

Langkah-langkah dalam metode ANP adalah sebagai berikut:

A. Buatlah suatu hierarki jaringan keputusan yang menunjukkan hubungan antar faktor keputusan.
B. Buatlah perbandingan berpasangan di antara faktor yang mempengaruhi keputusan.
C. Hitunglah *relative importance weight vectors* dari faktor-faktor tersebut.
D. Buatlah suatu supermatriks, yaitu suatu matriks yang tersusun dari *relative importance weight vectors*. Setelah itu, normalisasikan supermatriks tersebut sehingga angka-angka di dalam tiap-tiap kolom pada supermatriks memiliki jumlah bernilai 1 (satu).
E. Hitunglah bobot akhir dengan meningkatkan supermatriks dengan *2k+1* dimana *k* merupakan sembarang angka yang besar sampai stabilitas bobot terjadi, dimana nilai-nilai dalam supermatriks tidak berubah ketika dikalikan dengan dirinya sendiri, yang disebut sebagai konvergen.

ANALISA DAN PEMBAHASAN

Gambaran Kawasan Industri Cikarang dan Sekitarnya

Kota Cikarang berada di Kabupaten Bekasi yang berlokasi 34 km sebelah timur Jakarta. Kota Cikarang dikenal sebagai kota industri terbesar di Asia Tenggara yang membuka peluang bagi investor untuk menanamkan modal di sana. Saat ini, Kawasan Industri di Kota Cikarang telah menjadi salah satu pusat industri nasional yang nilai ekspornya tinggi dengan sekitar 2.125 unit pabrik dari 25 negara investor berlokasi di kawasan tersebut. Kawasan Industri ini mampu menyumbang sebesar 34,46% Penanaman Modal Asing Nasional, serta 22-45% volume ekspor nasional.

Tercatat sepuluh kawasan industri sudah berada di Bekasi, Jawa Barat (tujuh diantaranya di Kota Cikarang), antara lain Jababeka Industrial Estate, MM2100 Industrial Town BFIE, MM2100 Industrial Town MMID, EJIP (East Jakarta Industrial Park), BIIE (Bekasi International Industrial Estate), Lippo Cikarang Industrial Park, Kawasan Industri Terpadu Indonesia China, Greenland International Industrial Center (GIIC), Kawasan Industri Gobel, Kawasan Industri Marunda Center. (http://www.kemenperin.go.id/kawasan).

Berdasarkan data dari BPKM RI (Badan Koordinasi Penanaman Modal Republik Indonesia), dapat dilihat pertumbuhan investasi di bidang Industri. Sektor kegiatan sekunder yang masuk dalam kategori ini adalah industri makanan, tekstil, kulit, kertas, kimia dan farmasi, karet, plastik, mineral non logam, mesin dan elektronik, instrumen, otomotif, dan aneka industri.

Besarnya pertumbuhan investasi ini menjadi tantangan tersendiri bagi setiap industri/perusahaan dalam memenuhi setiap peraturan pengelolaan lingkungan hidup di Indonesia. Oleh karena itu, dibutuhkan juga rantai pasok yang mempertimbangkan aspek keberlanjutan dan lingkungan, untuk meningkatkan efisiensi dan efektifitas pabrik/perusahaan dalam penaatan aspek lingkungan di Indonesia. Beberapa jenis industri yang memiliki potensi kebutuhan akan *green supplier* di antaranya industri kimia,

pertambangan, farmasi, makanan, tekstil, logam, elektronik, mineral non logam, dan otomotif.

Pada Tahun 2014, sesuai dengan data HKI (Himpunan Kawasan Industri Indonesia) tercatat ada 233 Perusahaan Pengembang Kawasan Industri, yang mengembangkan lahan seluas 81.060 hektar. Dari total Pengembang Kawasan Industri di atas, 53 perusahaan diantaranya berlokasi di sepanjang ruas jalan Tol Jakarta Cikampek, yaitu di Kabupaten Bekasi, Karawang dan Purwakarta yang mengembangkan seluas total 9.384 ha (23 perusahaan) di Bekasi, 15.718 ha (20 perusahaan) di Karawang dan 3.062 ha (10 perusahaan) di Purwakarta, atau total sebesar 28.164 ha atau sebesar 34.7% dari total pengembangan kawasan industri di seluruh Indonesia. Untuk melihat potensi rantai pasok yang berorientasi aspek lingkungan/ *green supply chain*, maka dievaluasi data Kawasan Industri Koridor Cibitung-Cikampek, yaitu mengenai Jenis Industri yang berpeluang membutuhkan *green supplier*.

Dari data jenis industri dikelompokkan ke dalam 5 kelompok industri, yaitu kimia, makanan, kosmetik, otomotif, dan perakitan. Diasumsikan kelompok industri kimia, makanan, kosmetik dan otomotif akan membutuhkan *green supplier*, sedangkan kelompok industri perakitan tidak membutuhkan. Dari 175 Perusahaan di MM2100 di Cibitung, sebesar 38% berpotensi membutuhkan *green supplier*. Dari 1.378 perusahaan/industri di Jababeka, sebesar 26% berpeluang membutuhkan *green supplier*. Dari 103 perusahaan/industri di EJIP, sebesar 47% berpeluang membutuhkan *green supplier*. Dari 86 perusahaan/industri di KIIC, sebesar 41% berpeluang membutuhkan *green supplier*. Dari 86 perusahaan/industri di Bukit Indah dan indotaisei, sebesar 40 % berpeluang membutuhkan *green supplier*.

Tabel 1. Rekapitulasi Potensi Green Supplier

Kawasan Industri	*Jumlah Perusahaan*	*Potensi Green Supplier*
MM2100 Cibitung	*175*	*38%*
Jababeka	*1378*	*26%*
EJIP	*103*	*47%*
KIIC	*86*	*41%*
Bukit Indah dan Indotaisei	*86*	*40%*

N.B: Data Tahun 2014, dan sesuai asumsi penelitian

Identifikasi Kriteria *Green Supplier*

Perhatian terhadap isu lingkungan terus berkembang. Bahkan, di negara maju, konsumen sangat peduli pada produk yang dihasilkan oleh perusahaan yang peduli dengan lingkungan. Oleh karena itu, perusahaan mengalami tekanan untuk secara proaktif mengembangkan program-program yang peduli lingkungan (Min and Galle, 2001). Salah satu yang menjadi fokus perhatian perusahaan manufaktur adalah bagaimana memilih *supplier* yang peduli isu lingkungan, yang dikenal sebagai *green supplier*. Kriteria ramah lingkungan sudah mulai dikenal di negara maju mulai tahun 1990-an (Dobos and Vörösmarty, 2014). Kriteria pemilihan *green supplier* telah banyak dikembangkan oleh beberapa peneliti. Rangkuman kriteria yang digunakan dalam memilih *green supplier* dapat dilihat pada **Tabel 2** di bawah ini.

Tabel 2. Kriteria dalam *Green Supplier*

No.	Penulis	Negara	Metode Penelitian	*Kriteria*	Hasil
1.	(Jabbour and Jabbour, 2009)	Brazil	Case study	- *Reduction of chemical and toxic material substances* - *Quantitative analysis of environmental impact* - *Information database on supplier environmental performance* - *ISO 14001* - *Has a corporate manual of environmental criteria*	Ada beberapa yang belum menggunakan kriteria lingkungan

2.	(Zhu et al., 2010)	China	ANP	- *Pollution controls* - *Pollution prevention* - *Environmental management system* - *Resource consumption* - *Pollution production*	*Environmental management system* memiliki bobot terbesar
3.	(Lee et al., 2011)	Taiwan	FAHP	- *Pollution control* - *Green image* - *Environment-related certificates* - *Environmental purchasing managing systems* - *Environment practices*	kriteria lingkungan memiliki bobot terbesar dibandingkan kriteria lain
4.	(Bali et al., 2013)	Numerical example	IFS dan GRA	- *Service quality* - *Green image* - *Use of green materials* - *Pollution/waste control in production* - *Distribution* - *Reverse logistics* - *Green design or R&D*	-
5.	(Dobos and Vörösmarty, 2014)	Numerical example	DEA	- *Reusability (%)* - *CO_2 emission (g)*	-
6.	(Kannan et al., 2014)	Brazil	Fuzzy TOPSIS	- *Commitment of senior management to GSCM* - *Product designs that reduce, reuse, recycle, or reclaim materials, components, or energy* - *Compliance with legal environmental requirements and auditing programs* - *Product designs that avoid or reduce toxic or hazardous material use* - *Sale of used equipment (after buying new equipment)* - *Sale of scrap and used materials)*	Yang dominan: *Commitment of senior management to GSCM*; *Product designs that reduce, reuse, recycle, or reclaim materials, components, or energy; Compliance with legal environmental requirements and auditing programs; and Product designs that avoid or reduce toxic or hazardous material use*
7.	(Freeman and Chen, 2015)	China	AHP, Entropy, TOPSIS	- *Green material selection* - *Green image* - *Cleaner production technologies* - *Reduced green packaging* - *Use of toxic/restricted substances* - *Waste management* - *Remanufacturing/reuse activity* - *ISO-14001 certification*	-
8.	(Galankashi et al., 2015)	Malaysia	Fuzzy ANP	- *Use of green materials* - *Waste Level* - *Energy Efficiency* - *Green Design Capability*	Kriteria lain, seperti *price* dan *quality* masih lebih penting
9.	(Hashemi et al., 2015)	Iran	ANP, IGRA	- *Pollution production* - *Pollution control* - *Resource consumption* - *Eco-design* - *Environmental management system* - *Green image* - *Green competencies* - *Green product* - *Staff environmental training* - *Management commitment*	*Environmental management system* seperti ISO 14000 menjadi penyaring pertama untuk memastikan adanya kriteria "green" dalam seleksi supplier. Kriteria yang penting yaitu *pollution production*, *management commitment*, dan *resource consumption*
10.	(Awasthi and Kannan, 2016)	India	Fuzzy, NGT, VIKOR	- *Energy usage* - *Emissions* - *Noise* - *Green packaging* - *Green product design* - *Green transportation* - *Green warehousing* - *Green procurement*	Hal penting bagi *green supplier development* adalah adanya sertifikat ISO 14000, *employee development with environmental expertise*, dan *supplier training*

				- *Reverse logistics*	
11.	(Sahu et al., 2016)	-	FMLMCDM, Fuzzy-TOPSIS	- *Management competencies* - *Green image* - *Design for environment* - *Environmental management systems* - *Environmental competencies*	-
12.	(Hamdan and Cheaitou, 2017)	Arab	Fuzzy TOPSIS, AHP, Multi-objective ILP	*Product-related* - *Use of toxic substances* - *Use of resources* - *Environmental labeling* - *Recycled packaging* - *Green technology* *Organization-related* - *Certification of environmental management system* - *Environmental policy* - *Compliance to regulation* - *Evaluation of second tier suppliers* - *Staff training to increase awareness about environmental issues* - *Green market share*	-
13.	(Vijayvargy et al., 2017)	India	Statistical inferences	- *Internal environmental management* - *Green purchasing* - *Investment recovery* - *Customer environmental collaboration* - *Eco-design*	Berdasarkan hasil analisis, didapatkan bahwa usaha skala kecil masih belum terlalu menerapkan GSCM. Fokus dari perusahaan adalah membuat *environmental management system*, khususnya sertifikasi ISO 14001
14.	(Yazdani et al., 2017)	Iran	QFD, DEMATEL, COPRAS	- *Internal environmental management* - *Environmental management systems* - *Waste disposal program* - *Reverse logistics* - *Energy and natural resource consumption* - *Green design; Re-use and Recycle rate*	Yang paling berpengaruh adalah kriteria umum dan *environmental management systems*
15.	(Demir et al., 2018)	Turkey	VIKORSORT	- *Recycling program* - *Environment-friendly materials* - *Proper disposal of waste* - *Energy management* - *Waste recycling* - *Social responsibility projects* - *Environment-friendly product distribution* - *Emission measurement* - *Environment-conscious production* - *Training programs on environmental issues*	Yang tertinggi adalah kriteria *recycling* program, *waste recycling, environment-conscious production, training programs on environmental issues*, dan *energy management*

Seleksi Kriteria *Green Supplier* untuk Kawasan Industri Cikarang

Berdasarkan hasil kajian literatur di atas, didapatkan setidaknya ada 15 kriteria penting dalam menilai *green supplier*. Setelah mendapatkan kriteria tersebut, maka dilakukan penyaringan kriteria-kriteria penting dan sesuai dengan kondisi di kawasan industri Cikarang. Berdasarkan hasil kajian terhadap 15 kriteria dan didukung dengan hasil wawancara terhadap para ahli, diperoleh 10 kriteria yang sesuai untuk kawasan industri Cikarang. Adapun kriteria dan penjelasannya dapat dijelaskan pada **Tabel 3** sebagai berikut:

Tabel 3. Pembobotan Kriteria *Green Supplier*

No.	Kriteria	Definisi
1.	*Pollution prevention and control* (PLC)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki mekasisme pencegahan dan pengendalian terkait polusi udara, limbah cair, limbah padat, dan limbah kimia.
2.	*Environmental management system* (EMS)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki kebijakan terkait lingkungan, termasuk praktiknya terhadap pelanggan dan organisasi eksternal.
3.	*Green image* (GI)	Kriteria ini digunakan untuk menilai apakah *supplier* menjalankan dan menekankan pentingnya tanggung jawab sosial dan lingkungan. Selain itu, *supplier* juga mempromosikan produk dan layanannya dengan penekanan pada isu *sustainability*.
4.	*Environmental purchasing managing systems* (EPMS)	Kriteria ini digunakan untuk menilai apakah *supplier* menerapkan keputusan pembelian yang didasarkan pada prinsip lingkungan. Dengan kata lain, apakah *supplier* menerapkan kriteria lingkungan ke dalam pemilihan produk atau jasa yang ingin dibeli.
5.	*Green product labeling* (GPL)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki label "green" di produk yang dijual. Label ini menandakan usaha *supplier* dalam menciptakan produk yang dapat di daur ulang, dibungkus dengan material ramah lingkungan, dan menggunakan energi yang sedikit/efisien.
6.	*Green design or R&D* (GD)	Kriteria ini digunakan untuk menilai apakah *supplier* mengembangkan *green design* yang baru.
7.	*Energy management/efficiency* (EM)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki praktik dan upaya dalam mengefisienkan penggunaan energi.
8.	*Environment-related certificates* (ERC)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki sertifikat-sertifikat terkait lingkungan.
9.	*Reverse logistics* (RL)	Kriteria ini digunakan untuk menilai apakah *supplier* memiliki jaringan *reverse logistic* yang fokus pada pengembalian produk dan material untuk didaur ulang.
10.	*PROPER assesment from KLHK Indonesia* (PROPER)	Kriteria ini digunakan untuk menilai apakah *supplier* mengikuti Program Penilaian Peringkat Kinerja Perusahaan (PROPER) dari Kementerian Lingkungan Hidup dan Kehutanan (KLHK).

Pengembangan Model Pemilihan *Green Supplier*

Pada tahap ini maka akan dilakukan penyebaran kuesioner untuk mengembangan model pemilihan *green supplier* di kawasan industri Cikarang. Terdapat dua jenis kuesioner yang harus diisi oleh parah ahli. Kuesioner pertama bertujuan untuk mengetahui bagaimana pengaruh antar kriteria. Hasil dari kuesioner pertama akan diolah menggunakan metode DEMATEL. Hasil akhirnya berupa gambar relasi antar kriteria yang menjadi dasar untuk perhitungan metode ANP. Kuesioner kedua bertujuan untuk mengetahui tingkat kepentingan relatif dari setiap kriteria. Hasil dari kuesioner kedua nanti akan diolah untuk didapatkan ranking dari setiap kriteria pemilihan *green supplier* di kawasan industri Cikarang.

Penentuan Hubungan *Causal* Kriteria Menggunakan Metode DEMATEL

Pada penelitian ini diperolah lima ahli dari akademisi yang mengisi kuesioner pertama untuk mengetahui pengaruh dari kriteria satu ke kriteria lainnya.

Langkah pertama pada analisis DEMATEL adalah membuat matrik Z, yaitu matrik rata-rata jawaban dari responden, sebagaimana yang ditunjukkan pada persamaan **(1).**

Tabel 4. Matrik Z rata-rata jawaban responden (Langkah 1 DEMATEL)

Z =										
	0	2.833	2	1.833	2.5	2.667	2.833	2.5	2.167	3
	3	0	2.833	3	2.667	2.5	3	2.667	2.333	3.167
	1.833	2.333	0	2.833	2.833	2.167	1.333	1.833	2.167	2.167
	1.5	2.333	1.5	0	1.667	2.5	1.667	1.5	1.833	2.333
	2.333	2.5	2.667	2.5	0	2.5	2.167	2.333	1.833	2.5
	2.167	1.667	2.667	2.167	2.167	0	2.167	2.5	1.833	2.167
	2.333	2.167	1.667	1.833	1.667	1.667	0	1.5	1.333	2.167
	1.833	2.333	2.667	2.167	2	1.833	2	0	1.5	2.667
	1.833	1.667	1.667	2	1.5	1.5	1.667	1.667	0	1.333
	2.667	2.667	2.333	2.333	2	1.833	2.5	2.5	1.5	0

Selanjutnya akan dibuat *the normalized initial direct-relation* matriks D berdasarkan persamaan **(2), (3),** dan **(4).** Hasil perhitungan ditunjukkan di bawah ini.

Tabel 5. *The Normalized Initial Direct-Relation* Matriks D (Langkah 2 DEMATEL)

D =										
	0	0.13	0.09	0.09	0.12	0.12	0.13	0.12	0.10	0.14
	0.14	0	0.13	0.14	0.12	0.12	0.14	0.12	0.11	0.15
	0.09	0.11	0	0.13	0.13	0.10	0.06	0.09	0.10	0.10
	0.07	0.11	0.07	0	0.08	0.12	0.08	0.07	0.09	0.11
	0.11	0.12	0.12	0.12	0	0.12	0.10	0.11	0.09	0.12
	0.10	0.08	0.12	0.10	0.10	0	0.10	0.12	0.09	0.10
	0.11	0.10	0.08	0.09	0.08	0.08	0	0.07	0.06	0.10
	0.09	0.11	0.12	0.10	0.09	0.09	0.09	0.00	0.07	0.12
	0.09	0.08	0.08	0.09	0.07	0.07	0.08	0.08	0	0.06
	0.12	0.12	0.11	0.11	0.09	0.09	0.12	0.12	0.07	0

Setelah itu menghitung *total relation matrix T* menggunakan persamaan **(5), (6),** dan **(7).** Hasil perhitungan ditunjukkan di bawah ini.

Tabel 6. Total Relation Matrik T (Langkah 3 DEMATEL)

T =										
	1.075	1.242	1.183	1.21	1.153	1.167	1.184	1.153	1.009	1.3
	1.311	1.246	1.329	1.374	1.271	1.274	1.302	1.27	1.113	1.431
	1.024	1.089	0.967	1.115	1.041	1.025	0.998	1.002	0.901	1.128
	0.895	0.965	0.912	0.873	0.881	0.92	0.895	0.875	0.787	1.005
	1.127	1.182	1.162	1.189	1.006	1.118	1.113	1.103	0.959	1.232
	1.03	1.057	1.071	1.082	1.01	0.925	1.023	1.021	0.882	1.121
	0.912	0.944	0.902	0.935	0.867	0.873	0.808	0.86	0.754	0.983
	1.007	1.071	1.059	1.07	0.992	0.992	1.006	0.906	0.859	1.127
	0.809	0.838	0.818	0.855	0.779	0.786	0.797	0.785	0.625	0.86
	1.1	1.148	1.109	1.14	1.053	1.054	1.087	1.07	0.912	1.086

Total penjumlahan baris dan kolom dihitung dengan menggunakan persamaan **(8)** dan **(9).** Hasil perhitungan dapat dilihat pada **Tabel 7** di bawah ini.

Tabel 7. Total pengaruh yang diberikan dan diterima setiap kriteria

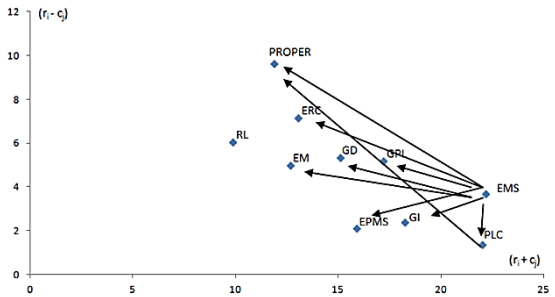
	PLC	EMS	GI	EPMS	GPL	GD	EM	ERC	RL	PROPER	r_i	c_j	$(r_i + c_j)$	$(r_i - c_j)$
PLC	1.07539	1.24166	1.18298	1.20991	1.15301	1.16712	1.18433	1.1534	1.00872	**1.29965**	11.6762	10.2899	21.966	1.3862
EMS	**1.3109**	1.24554	**1.32943**	**1.37433**	**1.27092**	**1.27416**	**1.30233**	**1.2698**	1.11317	**1.43074**	12.9213	9.21455	22.136	3.7068
GI	1.02425	1.08907	0.9668	1.11518	1.04146	1.02453	0.99782	1.00247	0.90138	1.1277	10.2907	7.90365	18.194	2.387
EPMS	0.89495	0.96483	0.91246	0.87312	0.88107	0.92	0.89511	0.87512	0.78683	1.00493	9.00843	6.8794	15.888	2.129
GPL	1.12662	1.18235	1.16198	1.18889	1.00586	1.11796	1.11256	1.10251	0.95855	1.23168	11.189	5.98444	17.173	5.2045
GD	1.03032	1.05742	1.07075	1.08183	1.01007	0.9254	1.02311	1.02131	0.88195	1.12078	10.2229	4.85782	15.081	5.3651
EM	0.91155	0.94374	0.90202	0.93463	0.86651	0.87301	0.80819	0.8596	0.75389	0.98285	8.836	3.8275	12.663	5.0085
ERC	1.00683	1.0707	1.05891	1.07029	0.99246	0.99248	1.00572	0.9058	0.85889	1.12747	10.0895	2.91595	13.005	7.1736
RL	0.80868	0.83776	0.81781	0.85497	0.77932	0.78558	0.79713	0.78482	0.62534	0.85969	7.95111	1.90912	9.8602	6.042
PROPER	1.10044	1.14826	1.10856	1.14046	1.05254	1.05373	1.08741	1.07028	0.9117	1.08561	10.759	1.10044	11.859	9.6586

Setelah mendapatkan tabel pengaruh di atas, maka dilakukan penentuan *threshold* berdasarkan persamaan **(10).** Perhitungannya adalah sebagai berikut:

$$\alpha = 102{,}944/100 = 1{,}02944$$

Jika membandingkan nilai t_{ij} dengan α , terlihat banyak sekali t_{ij} yang bernilai yang benilai lebih dari α. Oleh karena itu, disepakati kembali dengan para ahli untuk menentukan *threshold* yang tinggi agar didapatkan kriteria dominan saja. Nilai *threshold* yang ditentukan adalah 1,25. Nilai t_{ij} pada **Tabel 7** yang benilai lebih dari 1,25; ditandai dengan cetak tebal.

Setelah itu, dibuatlah *causal diagram* dengan memetakan koordinat kriteria $(r_i + c_j,\ r_i - c_j)$. Kemudian dibuatlah diagram hubungan sesuai dengan nilai t_{ij} yang lebih dari α. *Causal diagram* dari kriteria pemilihan *green supplier* dapat dilihat pada **Gambar 2**.



Gambar 2 *Causal Diagram* Kriteria

Penentuan Bobot Tingkat Kepentingan Relatif Kriteria Menggunakan Metode ANP

Setelah mendapatkan *causal diagram* kriteria, maka akan ditentukan bobot tingkat kepentingan relatif kriteria menggunakan metode ANP. Perhitungan bobot akan dilakukan dengan bantuan *software super decisions*. Sebelum memasukkan nilai perbandingan berpasangan, pertama harus dibuat terlebih dahulu model ANP, yang relasinya sesuai dengan hasil pada **Gambar 2**. Setelah membuat model ANP, kemudian dilakukan input data nilai *geometric mean* dari jawaban responden pada kuesioner 2. Berdasarkan hasil analisis ANP dapat disimpulkan urutan prioritas kriteria dalam model pemilihan *green supplier*, sebagai berikut:

Tabel 8. Pembobotan Kriteria *Green Supplier*

No.	Kriteria	Bobot
1.	*Environmental management system* (EMS)	0,17554
2.	*PROPER assesment from KLHK Indonesia* (PROPER)	0,14298
3.	*Pollution prevention and control* (PLC)	0,14110
4.	*Energy management/efficiency* (EM)	0,10950
5.	*Green design or R&D* (GD)	0,08885
6.	*Environmental purchasing managing systems* (EPMS)	0,08753
7.	*Reverse logistics* (RL)	0,07436
8.	*Environment-related certificates* (ERC)	0,07183
9.	*Green image* (GI)	0,05902
10.	*Green product labeling* (GPL)	0,04929

KESIMPULAN

Terdapat sepuluh kriteria yang dapat diterapkan untuk pemilihan green supplier di kawasan industri Cikarang. Kriteria tersebut mencakup unsur material, produk, hingga sistem manajemen lingkungan secara keseluruhan. Prioritas kriteria *green supplier* di kawasan industri Cikarang

adalah: *Environmental management system (EMS), PROPER assesment from KLHK Indonesia (PROPER),* dan *Pollution prevention and control (PLC), Energy management/ efficiency (EM),* dan *Green design or R&D (GD*), secara berurutan.

UCAPAN TERIMA KASIH

Ucapan terima kasih penulis sampaikan kepada Lembaga Riset dan Pengabdian Masyarakat, Universitas Presiden yang telah mendanai penelitian ini sebagai bagian dari Hibah Internal LRPM 2018. Ucapan terima kasih juga penulis sampaikan kepada setiap narasumber ahli yang mendukung pelaksanaan penelitian ini.

DAFTAR PUSTAKA

Awasthi, A., Kannan, G., 2016. Green supplier development program selection using NGT and VIKOR under fuzzy environment. Comput. Ind. Eng. 91, 100–108. https://doi.org/10.1016/j.cie.2015.11.011.

Bai, C., & Sarkis, J. (2010). "Green supplier development: Analytical evaluation using rough set theory." Journal of Cleaner Production, 18(12), 1200–1210.

Bali, O., Kose, E., Gumus, S., 2013. Green supplier selection based on IFS and GRA. Grey Syst. Theory Appl. 3, 158–176. https://doi.org/10.1108/GS-04-2013-0007.

Buyukozkan, Gulcin and Cifci, Gizem, (2011), "A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers", Expert System with Applications.

Cinelli, M., Coles, S.R., Kirwan, K., (2014), "Analysis of the potentials of multi criteria decision analysis methods to conduct sustainability assessment", Ecol. Indic. 46, pp. 138-148.

Demir, L., Akpınar, M.E., Araz, C., Ilgın, M.A., 2018. A green supplier evaluation system based on a new multi-criteria sorting method: VIKORSORT. Expert Syst. Appl. 114, 479–487. https://doi.org/10.1016/j.eswa.2018.07.071

DETR. (1999). Sustainable Distribution A Strategy. Office of the Deputy Prime Minister (ODPM), UK.

Dobos, I., Vörösmarty, G., 2014. Green supplier selection and evaluation using DEA-type composite indicators. Int. J. Prod. Econ. 157, 273–278. https://doi.org/10.1016/j.ijpe.2014.09.026

Emas, R. (2015), "The Concept of Sustainable Development: Definition and Defining Principles", Florida International University, Miami.

Ewertowska A, Galán-Martín A, Guillén-Gosálbez G, Gavaldá J, Jiménez L, (2016), "Assessment of the environmental efficiency of the electricity mix of the top European economies via data envelopment analysis", Journal of Cleaner Production.

Ewertowska A, Pozo C, Gavaldá J, Jiménez L, Guillén-Gosálbez G, (2017), Combined use of life cycle assessment, data envelopment analysis and Monte Carlo simulation forquantifying environmental efficiencies under uncertainty, Journal of Cleaner Production.

Freeman, J., Chen, T., 2015. Green supplier selection using an AHP-Entropy-TOPSIS framework. Supply Chain Manag. Int. J. 20, 327–340. https://doi.org/10.1108/SCM-04-2014-0142

Galankashi, M.R., Chegeni, A., Soleimanynanadegany, A., Memari, A., Anjomshoae, A., Helmi, S.A., Dargi, A., 2015. Prioritizing Green Supplier Selection Criteria Using Fuzzy Analytical Network Process. Procedia CIRP 26, 689–694. https://doi.org/10.1016/j.procir.2014.07.044

Gosalbez, Gonzalo G., (2011), "A novel MILP-based objective reduction method for multi-objective optimization: Application to environmental problems", Computer and Chemical Engineering, 35, pp. 1469-1477.

Gumus, A. T. (2009). "Evaluation of hazardous waste transportation firms by using a two step fuzzy-AHP and TOPSIS methodology." Expert Systems with Applications, 768 36, 4067–4074.

Hamdan, S., Cheaitou, A., 2017. Supplier selection and order allocation with green criteria: An MCDM and multi-objective optimization approach. Comput. Oper. Res. 81, 282–304. https://doi.org/10.1016/j.cor.2016.11.005

Hashemi, S.H., Karimi, A., Tavana, M., 2015. An integrated green supplier selection approach with analytic network process and improved Grey relational analysis. Int. J. Prod. Econ. 159, 178–191. https://doi.org/10.1016/j.ijpe.2014.09.027

Jabbour, A.B.L.S., Jabbour, C.J.C., 2009. Are supplier selection criteria going green? Case studies of companies in Brazil. Ind. Manag.

Data Syst. 109, 477–495. https://doi.org/10.1108/02635570910948623

Kannan, D., Jabbour, A.B.L. de S., Jabbour, C.J.C., 2014. Selecting green suppliers based on GSCM practices: Using fuzzy TOPSIS applied to a Brazilian electronics company. Eur. J. Oper. Res. 233, 432–447. https://doi.org/10.1016/j.ejor.2013.07.023

Kim, I., Min, H., 2011. Measuring supply chain efficiency from a green perspective. Manag. Res. Rev. 34, 1169–1189. https://doi.org/10.1108/01409171111178738

Lee, A. H. I., Kang, Y., Hsu, H. C-F., & Hung, H.-C. (2009). "A green supplier selection model for high-tech industri". Expert Systems with Applications, 36, pp. 7917–7927.

Lee, T. (Jiun-Shen), Phuong Nha Le, T., Genovese, A., Koh, L.S.C., 2011. Using FAHP to determine the criteria for partner's selection within a green supply chain: The case of hand tool industri in Taiwan. J. Manuf. Technol. Manag. 23, 25–55. https://doi.org/10.1108/17410381211196276

Martin, Angel G, Gosalbes, G.G., Stamford, Laurence, (2016), "Enhanced data envelopment analysis for sustainability assesment: A novel methodology and application to electricity technologies", Computer and Chemical Engineering, 90, pp. 188-200.

Min, H., Galle, W.P., 2001. Green purchasing practices of US firms. Int. J. Oper. Prod. Manag. 21, 1222–1238. https://doi.org/10.1108/EUM0000000005923

Saaty, T.L., (1999), "Decision Making for Leaders", 3rd ed., RWS Publications: Pittsburgh, PA.

Sahu, A.K., Datta, S., Mahapatra, S.S., 2016. Evaluation and selection of suppliers considering green perspectives: Comparative analysis on application of FMLMCDM and fuzzy-TOPSIS. Benchmarking Int. J. 23, 1579–1604. https://doi.org/10.1108/BIJ-12-2014-0111

Senthilkumaran, D., Ong, S.K., Tan, B.H. and Nee, A.Y.C. (2001), "Environmental life cycle cost analysis of products", Environmental Management and Health, Vol. 12 No. 3, pp. 260-276.

Tzeng, G.H., Chiang, C.H., Li, C.W. (2007). "Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATE"L. Expert Systems with Applications, 32 (4), 1028–1044.

Van Hock, R. I., & Erasmus (2000). "From reversed logistics to green supply chains." Logistics Solutions, 2, 28–33.

Vijayvargy, L., Thakkar, J., Agarwal, G., 2017. Green supply chain management practices and performance: The role of firm-size for emerging economies. J. Manuf. Technol. Manag. 28, 299–323. https://doi.org/10.1108/JMTM-09-2016-0123

WCDE (1987), "Our Common Future", Oxford University Press, Oxford.

Yazdani, M., Chatterjee, P., Zavadskas, E.K., Hashemkhani Zolfani, S., 2017. Integrated QFD-MCDM framework for green supplier selection. J. Clean. Prod. 142, 3728–3740. https://doi.org/10.1016/j.jclepro.2016.10.095

Zhu, Q., Dou, Y., Sarkis, J., 2010. A portfolio-based analysis for green supplier management using the analytical network process. Supply Chain Manag. Int. J. 15, 306–319. https://doi.org/10.1108/13598541011054670

Pemanfaatan Limbah Organik Berbasis *Bio Cyclo Farming* (Studi Kasus di Desa Telaga Murni)

Hiqmatus Sholichah[1] dan Annisa Nur Wahyuni [2]
Faculty of Engineering, President University
Jl. Ki Hajar Dewantara, Jababeka Education Park, Cikarang, Jawa Barat 17550
[1]Sholichahhiqmatus@gmail.com, [2]Annisan.nur.wahyuni@gmail.com

Abstract: *Basically, United States Environmental Protection Agency (USEPA) stated that urban development depends on 3 pillars namely economic, social and environmental which can realize the balance of national development. Urban development is an important part of increasing the quality of the environment, living standards, capabilities and independence of the community. Urban development is focused on a city system that is strong, dynamic, and organized on the proper sustainability system. Urban areas have increasingly important roles with activities such as service centers, centers of production, distribution, and centers of innovation and socio-cultural progress. Youth as the nation's generation must play an active role in building urban balance, especially building community welfare in the form of real work, for example through the "Bricus-system" youth activity based on Bio Cyclo Farming which focuses on managing organic waste as a medium for cultivating earthworms (Lumbricus Rubellus) by reducing organic waste and carry out waste management processes to be reused in other sectors. Therefore, it is necessary to develop certain areas that can reduce the risk of large-scale waste production, are environmentally sound and streak on the application of the concept of Bio Cyclo Farming, in this case, we form a business plan as the concept of implementing these activities. The purpose of this research is to achieve the role of the youth "Bricus-system" to improve environmental conditions which have a reduced function by utilizing organic waste as a medium for cultivation of worms that are expected to improve environmental and economic conditions. The research method used is a case study by observing areas that have problems developing urban equilibrium and making improvements to the area through "Bricus-system" youth activities based on Bio Cyclo Farming.*

Keywords: *The Role of Youth, Lumbricus Rubellus, Organic waste, Socio-Economic, Environmentally Friendly.*

Abstrak: Pada dasarnya *United States Environmental Protection Agency (USEPA)* menyatakan bahwa pembangunan perkotaan bergantung pada 3 pilar yaitu ekonomi, sosial dan lingkungan yang dapat mewujudkan keseimbangan pembangunan nasional. Pembangunan perkotaan menjadi bagian penting dalam meningkatnya kualitas lingkungan, taraf hidup, kemampuan dan kemandirian masyarakat. Pembangunan perkotaan dititik beratkan pada sistem kota yang kuat, dinamis, dan diselenggarakan pada tata kesinambungan yang tepat. Kawasan perkotaan semakin penting peranannya dengan kegiatan seperti pusat pelayanan, pusat produksi, distribusi, serta pusat inovasi dan kemajuan sosial budaya. Pemuda sebagai generasi bangsa harus berperan aktif dalam membangun keseimbangan perkotaan terlebih membangun kesejahteraan masyarakat dalam bentuk kerja nyata contohnya melalui kegiatan pemuda "*Bricus-system"* berbasis Bio Cyclo Farming yang terfokus pada pengelolaan sampah organik sebagai media budidaya cacing tanah (*Lumbricus Rubellus*) dengan usaha mereduksi limbah organik dan melakukan proses pengelolaan limbah untuk dimanfaatkan kembali pada sektor lainnya. Oleh karena itu diperlukan pengembangan kawasan tertentu yang dapat mengurangi risiko produksi limbah skala besar, berwawasan lingkungan dan beruntun pada penerapan konsep Bio Cyclo Farming, dalam hal ini penulis menyusun *bussiness plan* sebagai konsep implementasi kegiatan tersebut. Tujuan yang ingin dicapai dalam penelitian ini adalah melalui kegiatan peran pemuda "*Bricus-system*" untuk memperbaiki kondisi lingkungan yang mengalami penurunan daya fungsi dengan memanfaatkan limbah organik sebagai media budidaya cacing yang diharapkan dapat memperbaiki kondisi lingkungan dan ekonomi. Metode penelitian yang digunakan adalah studi kasus dengan melakukan observasi terhadap daerah yang mengalami masalah pembangunan keseimbangan perkotaan dan melakukan perbaikan daerah tersebut melalui kegiatan pemuda "*Bricus-system*" berbasis Bio Cyclo Farming.

***Kata Kunci*:** Peran Pemuda, Lumbricus Rubellus, Limbah organik, Sosial- Ekonomi, Ramah Lingkungan.

PENDAHULUAN

Seperti yang kita ketahui menurut *United States Environmental Protection Agency (USEPA)*, pembangunan perkotaan bergantung pada 3 pilar yaitu ekonomi, sosial, dan lingkungan yang dapat membantu mewujudkan keseimbangan pembangunan nasional. Pembangunan

perkotaan dititik beratkan pada sistem kota yang kuat, dinamis, dan diselenggarakan pada tata kesinambungan yang tepat. Kawasan perkotaan semakin penting peranannya dengan kegiatan seperti pusat pelayanan, pusat produksi, distribusi, serta pusat inovasi dan sebagai pusat kemajuan sosial budaya. Seperti halnya kota Jababeka yang akan menjadi tempat penelitian peneliti. Kota Jababeka adalah sebuah kota berbasis industri mandiri terdapat rumah bagi lebih dari 1.650 lokal dan multinasional perusahaan dari lebih dari 30 negara, seperti Amerika Serikat, Jepang, Perancis, Inggris, Belanda, Australia, Korea, Singapura, Taiwan dan banyak lainnya. Kota Jababeka memiliki kawasan industri, perumahan dan komersial, jaringan transportasi umum, belanja, rekreasi dan tempat hiburan[1]. Dari analisa tersebut dapat terjadi kemungkinan masalah tata perkotaan karena faktor lingkungan maupun sosial yang belum seimbang, untuk itu dibutuhkan kesadaran diri dari individu maisng- masing untuk dapat memperbaiki masalah tata perkotaan melalui peran dari masyarakat maupun para pemuda.

Pemuda yang sadar akan potensi pesatnya industri di Cikarang, Jababeka memiliki peran aktif dalam mengkoordinasi sistem tata kota yang bersinergi dengan lingkungan, karena pemuda merupakan salah- satu bonus demografi yang sangat dibutuhkan oleh negara Indonesia untuk membantu mensukseskan pembangunan dibidang ekonomi, sosial dan lingkungan[2]. Disinilah peran pemuda sebagai generasi bangsa harus berperan aktif dalam membangun keseimbangan perkotaan terlebih membangun kesejahteraan masyarakat dalam bentuk kerja nyata contohnya melalui kegiatan pemuda "*Bricus- system"* berbasis Bio Cyclo Farming yang terfokus pada pengelolaan sampah organik sebagai media budidaya cacing tanah (*Lumbricus Rubellus*) dengan usaha mereduksi limbah organik dan melakukan proses pengelolaan limbah tersebut untuk dimanfaatkan kembali pada sektor lainnya.

Peran pemuda yang dimaksud adalah mahasiswa dari President University yang tergabung dalam suatu komunitas sosial dan memiliki tujuan untuk berkontribusi kepada masyarakat melalui kegiatan *Bricus-system* yang berbasis Bio Cyclo Farming. Sebab diperlukannya pengembangan kawasan tertentu yang dapat mengurangi risiko produksi limbah skala besar, berwawasan lingkungan dan beruntun pada penerapan konsep Bio Cyclo Farming, sehingga peneliti melakukan penelitian yang bertujuan untuk memperbaiki kondisi lingkungan yang mengalami penurunan daya fungsi dengan memanfaatkan limbah organik sebagai media budidaya cacing yang diharapkan dapat memperbaiki kondisi lingkungan dan ekonomi.

METODE PENELITIAN

Metode yang digunakan dalam penelitian ini adalah metode penelitian studi kasus. Pada proses tersebut terdapat beberapa teknik dalarn pengumpulan data, tetapi yang lebih dipakai dalam penelitian studi kasus adalah observasi, wawancara, dan analisis dokumentasi[3]. Disini peneliti melakukan observasi kasus yang terjadi disekitar daerah Cikarang Barat dengan bantuan LPPM (Lembaga Pengabdian dan Pemberdayaan Masyarakat) yang menyalurkan jasanya untuk memberikan data desa mana yang membutuhkan implementasi dari konsep *Bricus-System* berbasis Bio Cyclo Farming yang kemudian disosialisasikan kepada masyarakat dan melakukan wawancara pada salah satu peternak cacing *Lumbricus Rubellus* sebagai narasumber untuk menambahkan data yang telah diperoleh kemudian melakukan analisis, analisa data dilakukan sejak peneliti di lapangan, sewaktu pengumpulan data dan setelah semua data terkumpul atau setelah selesai dari lapangan, disini peneliti melakukan survei ke salah satu daerah yang ada di Cikarang Barat yaitu desa Telaga Murni,

atas jasa kerjasama dengan LPPM (Lembaga Pengabdian dan Pemberdayaan Masyarakat) peneliti mendapatkan data yang lebih akurat dan dapat melakukan penyempurnaan dari data sebelumnya untuk dijadikan laporan penelitian.

HASIL DAN PEMBAHASAN

Sebelum kami melakukan implementasi dari kegiatan peran pemuda *"Bricus-System",* kami mencari program kerja yang dapat dilakukan di desa Telaga Murni dan dapat mendukung aktifitas kawasan industri Jababeka yaitu dengan budidaya cacing tanah *Lumbricus Rubellus*. Kemudian kami bentuk sebagai *business plan* yang bertujuan untuk mengetahui kelayakan ekonominya. Berikut merupakan jalannya proses produksi dan rincian *bussiness plan*:

1. PROSES PRODUKSI

(Berdasarkan hasil wawancara dengan Bapak Hidayat)

Bahan dan peralatan pembuatan media cacing:

a. Tanah
b. Rak, bak, plastic
c. Kandang
d. Pelepah pisang, kotoran sapi, grajen kayu sengon
e. Limbah organik pasar

Tahap pembuatan media cacing:

1. Siapkan kotoran sapi 1 ember
2. Siapkan grajen kayu sengon 1 ember
3. Cacah pelepas pisang kecil-kecil
4. Campur hingga rata, dan masukkan ke dalam rak tempat hunian cacing
5. Cacing siap ditanam

Tahap pembuatan pakan cacing:

a. Blender halus bahan organic
b. Campurkan kotoran lembu secukupnya
c. Campurkan ampas tahu
d. Aduk secara rata dan tunggu 1 malam
e. Tuang pakan tersebut kesela-sela rak budidaya cacing

2. RENCANA BISNIS

Deskripsi Usaha

a. Bidang Usaha Dan Jenis Produk. Bidang usaha yang akan dilakukan dalam kegiatan *Bricus-System* yaitu usaha budidaya cacing yang telah dikembangkan untuk kepentingan komersial. Produk yang difokuskan untuk dipasarkan adalah cacing tanah jenis *Lumbricus Rubellus* yang dijual segar per kilogram beratnya. Selain itu terdapat produk lain yang bisa dijual yaitu kascing yang bisa dijadikan pupuk organik bagi para petani.

b. Kegunaan Dan Keunggulan. Kegunaan dari usaha ini diharapkan dapat menyediakan cacing segar *Lumbricus Rubellus* dalam rangka memenuhi kebutuhan Industri farmasi dan kosmetik terutama yang berada di Jababeka seperti PT. Dexa, PT. Feron Pharmacentical. Selain itu dapat memenuhi kebutuhan pakan untuk peternak burung, peternak ikan dan peternak bebek.

c. Lokasi Usaha. Usaha ini akan berlokasi di desa Telaga Murni, Cikarang Barat, Jawa Barat.

d. Waktu. Memulai usaha ini adalah sejak usulan rencana bisnis ini disetujui oleh LPPM (Lembaga Pengabdian dan Pemberdayaan Masyarakat) Jababeka untuk diimplementasikan di desa Telaga Murni.

e. Dampak Usaha Terhadap Lingkungan Usaha yang akan didirikan diharapkan dapat meningkatkan taraf hidup baik pelaksana maupun orang lain yang berkerja di usaha ini. Dari sisi sosial, dapat mempekerjakan masyarakat disekitar tempat usaha sehingga dapat mengurangi jumlah pengangguran. Dari sisi lingkungan, dapat memperbaiki kesuburan tanah yang mengalami penurunan karena kandungan dari Kascing tersebut[4], dari sisi ekonomi, dapat membuka peluang usaha baru bagi masyarakat ekonomi bawah.

f. Resiko Bisnis

Resiko Internal

Resiko internal yang akan dihadapi sebagian besar adalah masalah teknis peternakan[5]. Contohnya seperti masalah pemberian pakan cacing *Lumbricus Rubellus*, penjadwalan dan sebagainya. Resiko internal lain adalah adanya kesalah-pahaman tugas para pekerja.

Resiko Eksternal

- Terjadi serangan hama tikus
- Menurunnya daya beli masyarakat
- Munculnya pesaing dibidang usaha ini
- Tidak tercapainya target penjualan.

Rencana Pemasaran

a. Segmentasi Pasar
b. Berdasarkan wilayah distribusi dan kemampuan konsumen yang akan mnjadi segmen pemasaran produk cacing tanah adalah peternak, distributor pakan diwilayah Cikarang Barat, PT. Jababeka Infrastruktur, PT. Dexa Medica Jababeka dan PT. Feron Pharmacentical.
c. Berdasarkan pendapatan. Pendapatan menengah kebawah mengarah kepada peternak untuk dikonsumsi sendiri. Pendapatan menengah keatas mengarah kepada distributor maupun industri pupuk kosmetik, dan pakan ternak untuk diolah kembali.
d. Berdasarkan hobi. Segmentasi kami adalah orang yang suka memancing, serta hobi berternak.
e. Target Pasar. Setelah menentukan segmentasi pasar, maka yang akan menjadi target pasar adalah peternak, serta distributor diwilayah Cikarang. Sementara umumnya adalah serta pelaku usaha bidang obat dan kosmetik diwilayah Cikarang terutama kawasan industri Jababeka dan sekitarnya yang peternak belum mengenal betul dengan produk cacing sebagai pakan ternak.

Strategi Pasar

Strategi pasar dapat diaplikasikan khususnya pada empat hal yaitu pada produk itu sendiri, harga produk, promosi produk kepada pasar, dan distribusi produk untuk dapat sampai pada konsumen[6]. Strategi pemasaran penting untuk direncanakan dan dipertimbangkan agar kegiatan usaha yang dilakukan tidak kalah bersaing dengan usaha lain yang bergerak dalam bidang yang sama. Strategi pasar yang digunakan 4P yaitu *product, price, promotion*, dan *place*[7].

a. *Produc*t (Produk)

Produk yang difokuskan untuk dipasarkan adalah cacing tanah jenis *Lumbricus Rubellus* yang dijual segar per kilogram beratnya. Strategi yang digunakan untuk produk adalah keseragaman ukuran cacing melalui pengaturan pemberian pakan dan kebersihan cacing yang dipasarkan. Produk cacing ini merupakan salah satu produk yang memiliki multifungsi, baik untuk kepentingan persediaan industri pakan ternak dan ikan nasional, memasok kebutuhan farmasi dan obat-obatan, mengubah limbah organik menjadi media tanam yang baik dalam mendukung usaha pertanian, serta menumbuhkan usaha ekonomi kerakyatan[8]. Untuk produk kascing dijual kepada konsumen dan diberikan gratis untuk petani disekitar usaha ini.

b. Price

Harga yang ditetapkan untuk cacing dihitung per kilogram (kg), dimana dipasar untuk satu kilogram cacing tanah dijual dengan harga kisaran antara Rp. 50.000-70.000, harga yang ditetapkan dalam usaha ini adalah Rp. 60.000 per kg. Untuk konsumen yang menjadi pelanggan tetap tidak menutup kemungkinan untuk mendapatkan potongan harga dan untuk pemesan berskala besar juga akan mendapatkan potongan harga.

c. Promotion (promosi)
Usaha ini merupakan usaha baru dalam budidaya cacing *Lumbricus Rubellus* sehingga publikasi kepada konsumen sangat penting untuk dilakukan agar para konsumen dapat mengetahui adanya perusahaan disekitar mereka yang memproduksi cacing tanah. Untuk awal kami melakukan promosi dari mulut ke mulut dengan memanfaatkan hubungan baik dengan warga sekitar lokasi yang pada umumnya merupakan petani, peternak ikan, belut dan ayam di wilayah Cikarang Barat dan menjalin kerjasama dengan industri farmasi yang berada di kawasan Jababeka seperti PT. Dexa Medika, PT. Feron Pharmacentical, dan PT. Jababeka Infrastruktur. Untuk kedepannya kami melalukan promosi melalui media sosial seperti facebook, dan melalui pembuatan web atau blog agar lebih dikenal di wilayah Cikarang Barat dan sekitarnya.

d. Place (lokasi)
Pemilihan lokasi produksi merupakan salah satu alasan untuk menunjang distribusi produk kepada konsumen. Terjangkaunya lokasi oleh sarana transportasi akan memudahkan penyaluran produk kepada konsumen[9]. Sistem distribusi yang diterapkan untuk usaha ini adalah pengantaran langsung kepada konsumen dengan maksud memudahkan dan memanjakan konsumen agar tertarik untuk memesan produk. Tentu saja dengan memperhatikan lokasi konsumen dan skala pemesanan, untuk wilayah sekitar produksi tidak dikenakan tarif transportasi, sedangkan untuk luar wilayah produksi akan dikenakan biaya transportasi sesuai dengan lokasi konsumen, semakin jauh konsumen maka semakin besar pula tarif yang akan dikenakan.

Rencana Manajemen
a. Bentuk Usaha
Usaha ini berbentuk persekutuan karena dilihat dari jumlah pengelola yang menjalankan usaha peternakan cacing *Lumbricus Rubellus*.

b. Jumlah Tenaga Kerja
Manajer : 1 orang
Bagian peternakan : 1 orang
Bagian penjualan : 1 orang
Bagian akuntansi : 1 orang
Karyawan : 3 orang

c. Rencana Mitra
1. PT Jababeka Infrastruktur (Bagian Estate Management) yang mengelola sampah di Kawasan Industri Jababeka (KIJ) Cikarang dan mengoperasikan unit composting yang berlokasi di WWTP (*Waste Water Treatment Plant*).
2. LPPM (Lembaga Pengabdian dan Pemberdayaan Masyarakat) PT Jababeka Infrastruktur.
3. PT Dexa Medica.
4. PT. Feron Pharmaceutical.

Keterkaitan Kerjasama antara Pemangku Kepentingan (Stakeholders)
Pemangku kepentingan **:**
a. Akademisi: President University
b. Masyarakat: Desa Telaga Murni
c. Lembaga Pengabdian dan Pemberdayaan Masyarakat

Gambar 1 Kolaborasi skematis geografis antara para stakeholder di gambarkan sebagai berikut (tanpa skala)

d. Pengelola Kota/Estate: PT Jababeka Infrastruktur (Bagian *Estate Management*) yang mengelola sampah di Kawasan Industri Jababeka (KIJ) Cikarang dan mengoperasikan unit

composting yang berlokasi di WWTP (*Waste Water Treatment Plant*).

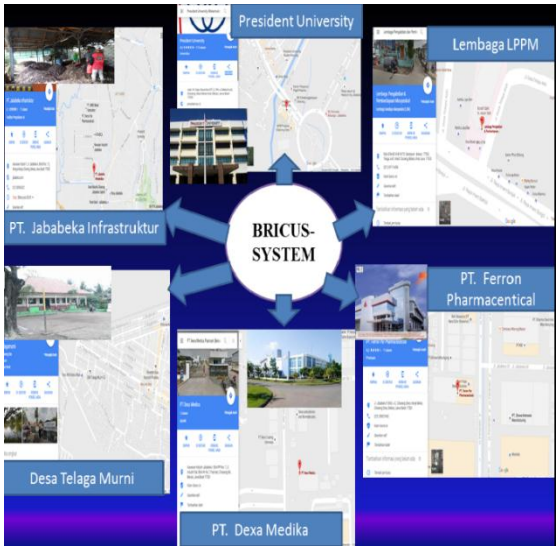
e. Industri: PT Dexa Medical dan PT. Feron Pharmaceutical

Rencana Arus Keuangan

Asumsi :

- Modal pinjam tanpa bunga
- Modal diperlukan setiap 4 bulan
- Penerimaan 80% pada rencana pendapatan yang berasal dari penjualan hasil

Sedangkan skema pola kerjasama antar stakeholders digambarkan sebagai berikut:



Gambar 2 Pola kerjasama antar stakeholders

Tabel 1 Arus Keuangan

Bahan	Quantity	Harga satuan	Perhitungan per bulan (x1000)			
			1	2	3	4
1. Sewa tanah seluas 100 m2 (per tahun)	100 m2		2.000			
2. Bangunan kandang bahan bambu (80 m2)	80 m2		2.000			
3. Rak 1.5 m x 1,8 m2 tinggi 50 cm	10	400.000	4.000			
4. Plastic kasting per kg	3000 kg	1500	4.500			
5. Bahan media cacing	6 ton	300.000	1.800			
6. Plastic	200 m	6000	1.200			
7. Pelepah pisang dicincang	5 karung	200.000	1000			
8. Benih Cacing	40 kg	50.000	2.000			
9. Pakan limbah sayur	5000 kg	500	2.500			
10. Tenaga kerja	3 orang	800.000	2.400	2.400	2.400	2.400
1. Transportasi	1	200.000/hari	1.200			4.000
Total			24.700	2.400	2.400	6.400
Cash in Produksi cacing	600 kg	60.000				36.000 x 80 % = 28.800
Produksi kascing	2 ton	15.000				30.000 x 80 % = 24.000
Total						52.800
Surplus			- 24.700	- 27.700	- 35.900	16.900 (47%)

Dari analisis arus kas di atas diperoleh nilai surplus sebesar 47 % (Rp 16.9000.000) dari total biaya yang diperlukan selama 4 bulan (Rp 35.900.000.). Dengan demikian usaha ini diproksikan layak untuk dapat dilaksanakan.

KESIMPULAN

Dari penjelasan tersebut, dapat ditarik beberapa kesimpulan sebagai berikut:

1. Dari analisis *business plan* kegiatan *"Bricus-System"* layak untuk diterapkan di Desa Telaga Murni karena berpotensi mendapat dukungan dalam hal pemasaran cacing *Lumbricus Rubellus* dari industri farmasi skala besar (PT. Dexa Medica, PT. Feron Pharmaceutical), peternak burung maupun ikan, dan tempat pemancingan, serta dukungan kerjasama dengan PT Jababeka Infrastruktur yang mempunyai Lembaga Pengabdian dan Pemberdayaan Masyarakat (LPPM).
2. Jika *bussiness plan* ini diimplementasikan akan memberikan dampak yang positif kepada masyarakat dan lingkungan yaitu membantu memperdayakan masyarakat ekonomi lemah dan juga membantu penyuburan tanah melalui kascing.
3. Dapat memberikan kesempatan peran pemuda yang besar terhadap jalannya bisnis ini mulai dari penanggung jawab sampai dengan pelaksana sehingga akan memberikan dampak sosial yang positif.

DAFTAR PUSTAKA

Kota Jababeka. 2015. http://www.jababeka.com/id/cikarang. Diakses pada tanggal 16 November 2016.

Naffs, Suzanne dan Ben White. 2012. Generasi Antara : Refleksi Tentang Studi Pemuda Indonesia. Jurnal Studi Pemuda. Vol.1 No. 2.

Margono,S. 2009. Metodologi Penelitian Pendidikan. Rineka Cipta, Jakarta.

Sudirja, R, 1999, Budidaya cacing tanah, Assosiasi kultur vermi Indonesia, Jatinangor.

Rahardi, F. dan R. Hartono, 2006. Agribisnis Peternakan. Cetakan kesepuluh. Penebar Swadaya, Jakarta.

Kumbhakar CS. 2002. Specification and estimation of production risk, risk preferences and technical efficiency. American Journal Agricultural Economic. 84(1): 8-22.

Jauch, lawrence R. 1993. Manajemen Strategis Dan Kebijakan Perusahaan, Erlangga, Jakarta.

Simantunjak, AK, D. Waluyo. 1982. Cacing dan Pemanfaatannya. PT. Penebar Swadaya Anggota IKAPI. Jakarta

Kotler, P. 2002. Manajemen Pemasaran. Edisi Kesepuluh, Jilid Dua.Terjemahan. Prenhallindo,Jakarta.

LPPM (Lembaga Pengabdian dan Pemberdayaan Masyarakat) Jababeka

Bapak Hidayat sebagai narasumber berpengalaman 5 tahun pada budidaya cacing Lumbricus Rubellus di Desa Telaga Murni, Cikarang Barat.

Rukmana, Ir. H. R. 2000. Budi Daya Cacing Tanah. Penerbit Kanisius, Yogyakarta.

Simantunjak, AK, D. Waluyo. 1982. Cacing dan Pemanfaatannya. PT. Penebar Swadaya Anggota IKAPI. Jakarta.

Kotler, P. 2002. Manajemen Pemasaran. Edisi Kesepuluh, Jilid Dua.Terjemahan. Prenhallindo,Jakarta.

Abdul Aziz A., M., 2015. Budidaya Cacing Tanah Unggul ala Adam Cacing. Jakarta: PT. Agro Media Pustaka.

THE ACADEMIC COMMUNITY PERCEPTION ABOUT IMPLEMENTATION OF UI GREENMETRIC-WASTE MANAGEMENT CRITERIA AT PRESIDENT UNIVERSITY

Kezia Kusumaningtyas[1], Ramadhani Fithratullah[2] and Clara Meluk[3]
Environmental Engineering, President University
Jababeka Education Park Jalan Ki Hajar Dewantara, Kota Jababeka, RT.2/RW.4,
Mekarmukti, Cikarang Utara, Bekasi, Jawa Barat 17550
[1] ningtyasecha@gmail.com, [2] Ramadhani.fithratullah@yahoo.com , [3] clarameluk1996@gmail.com

Abstract: Universitas Indonesia is the initiator of a UI GreenMetric World University international ranking system, which is a ranking system that aims to bring together universities that share the same goals in terms of sustainability. At present President University has participated in the ranking system. To find out the perceptions of the academic community on the implementation of the ranking system at President University, one of the criteria that is examined is waste management as one of the parameters of the GreenMetric UI. To get data, the method of direct observation is done to get the desired data by making a questionnaire in the form of a google form filled in by students and interview staff and operators at President University. Based on the results of data processing, it can be seen that the academic community at President University campus in general does not fully understand the waste management system on campus. So that education needs to be done about the management system developed on the internal campus of President University.

Keywords: *President University, UI GreenMetric World University Ranking, waste management*

Abstrak: *Universitas Indonesia menjadi penggagas suatu sistem rangking internasional UI GreenMetric World University Ranking, yang merupakan suatu sistem rangking yang bertujuan untuk menyatukan universitas yang memiliki tujuan yang sama dalam hal keberlanjutan. Saat ini President University telah turut berpartisipasi dengan sistem rangking tersebut, untuk mengetahui persepsi komunitas akademik terhadap impelementasi sistem rangking di President University, salah satu kriteria yang coba dikaji adalah mengenai pengelolaan sampah sebagai salah satu parameter dari UI GreenMetric. Untuk mendapatkan data, metode pengamatan langsung dilakukan untuk mendapatkan data yang diinginkan dengan cara membuat kuesioner dalam bentuk formulir google yang diisi oleh mahasiswa dan staf wawancara dan operator di President University. Berdasarkan hasil pengolahan data, dapat diketahui bahwa komunitas akademik di kampus President University secara umum belum begitu memahami sistem pengelolaan sampah di internal kampus. Sehingga perlu dilakukan edukasi mengenai sistem pengelolaan sampaah yang dikembangkan di internal kampus President University.*

Kata Kunci: *President University, UI Peringkat GreenMetric World University, pengelolaan limbah*

INTRODUCTION

Nowadays global warming and climate change is main topic in this era because of the temperature of earth is increasing. Several century temperature of earth was increase 0.7 ± 0.8°C. This phenomenon may happen because of several compound that produce from human activities, they are CO_2, CFC, CH_4, HF, SO_x, NO_x, etc. Emission was produce from fuel and combustion of forest/ or other kind of combustion. Emission simply said greenhouse gases (GHGs), the most of causing global warming and climate change (Kulkarni, 2017). People nowadays looking the solution for this problem, the solution obviously decrease producing of emission (Puspadi et al, 2016). Sustainability movement is nowadays event to sign that people aware to the environment.

The sustainability movement in higher education has been existed since the 1990s has made significant progress in research are, campus operations, strategic planning, and community service. Campus demonstrates its concern for ecological environment, by carrying out a series of new activities in sustainability. Sustainability campus is a global awareness, that every activity that is implemented by the campus and operational has an impact on the environment. There are 2 ways to support

campus sustainability, greening the campus and educating the academic community (Simangunsong, 2017). Greening the campus is instilling behavior of environmental friendly to all dimensions campus of infrastructure and operations. Educating the academic community that every activity has a good impact and bad impact can change the environmental. A collection of usual activities will become a habit. To prevent another impact have change the environmental there are several efforts sustainability which broadly defined to change in campus such as in operations, administrative planning, academic curriculum and facilitating research positive environmental change (Ravesteyn, 2014).

Green campus have several principles such as protecting the environment, lowering operating costs, improving the health and quality of the learning environmental, and integrating learning opportunities with the built environment. It's an ideal of green campus must be in standards. In the other hand green campus in an effort of sustainability campus means there are energy efficiency, can reduction in operational cost and reduction of environment (Kulkarni, 2017).

To achieve the goals many of campus has made the standard of green campus following the principles. UI GreenMetric World University Rankings is an initiative of Universitas Indonesia which being launched in 2010, and 619 universities with 77 countries in the world has participated in this organization. As the aim of this ranking to provide the result online survey regarding the current conditions and policies related to Green Campus and Sustainability in the universities all over the world. UI GreenMetric has standard or criteria regarding the ranking such as *setting and infrastructure, energy and climate change, waste, water, transportation and education.*

President University as the participant of UI GreenMetric World University Ranking has shown the awareness to the environment. But to be the participants it does not mean President University is a green campus, President University should completed all the criteria of UI GreenMetric. From six criteria we will take one criteria to be considered which waste criteria to be our focus research.

If there was a waste it must be a technique to be the solution. Solid Waste management is the technique to manage the waste and it is the multi nations problem that proved by perspective of history and perspective of UN policy, existent problem of Municipal Solid Waste Management in Kenya that amount of waste produced by their own citizen is growing alongside the uncontrolled disposal. All of this similar case needed to be seen as un-sustainability-lifestyle that needed to be fixed and start from the higher education to be the pioneers.

The aim of this paper is to find out President University civitas's perception and understanding about implementation of UI GreenMetric standard in President University, especially about the waste management.

MATERIAL AND METHODS

In order to get the data, we used two methods. The first method focused on collecting document from students in three batch (2016, 2017 and 2018). Filling out questionnaires use google form consist of 7 numbers of questionnaires and 31 respondents to see perspective of students about the process of waste in President University. Participant comes from three batches, to control the result. For second method, authors used interview methods, took 4 interviewed consist of 3 cleaning service and 1 staff campus. The objects are staff in university and representative of operators who responsible in waste management in university.

1. Questionnaires in the form of google forms: the information from student based on how far they know their campus. But because of authors make a control data by did survey to three batch. Estimation of the result is in actual and controlled.
2. Interview session : President University have department called General Affair (GA) where every student have a business with campus as general can go to that department. To get the data, authors interviewed staff on General Affair. In addition to complete the data, some operators who responsible to collect the waste also interviewed.

The aim of this method is to be able to collect data in detail, depth and also actual.

RESULT AND DISCUSSION

In every program, activity, or event also produce a waste but it could be maintained base on those who concerned to the program, activity, or event. From 31 responses (from batch active; 2016, 2017, 2018) they said, 29% not applicable, 22.6% partial (1% - 25% of waste), 32.3% partial (>25% - 50% of waste) and partial (>50% - 75% of waste) the value are 16.1% for each.

Waste criteria standard according to UI GreenMetric is a treatment of waste and any recycling activities are major factors in creating a sustainable environment.

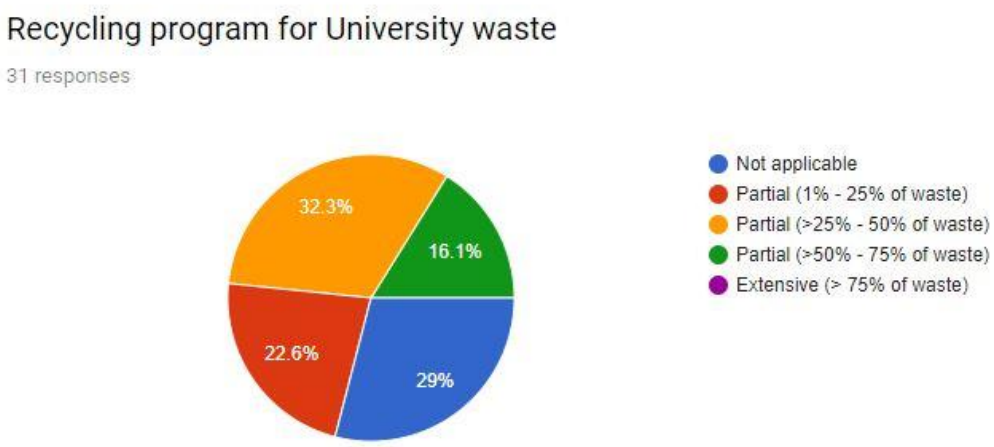


Figure 1. Recycle program for University waste

After we did 2 methods, first took a data using form and filled by 15 respondents from 3 batches, and second took a secondary data from interviewing the staff and operators. So, here are the results shown as below.

Data Analysis

Following the result of the form, there are six figures according to the indicators point of waste of UI GreenMetric, are shown the opinion from students from three batch:

1. Recycle Program for University Waste
2. Program to Reduce the Use of Paper and Plastic in Campus
3. Organic Waste Treatment
4. Inorganic Waste Treatment
5. Toxic Waste Treatment
6. Sewerage Disposal

The second UI GreenMetric give another point which a program to reduce the use of paper and plastic in campus, according to opinion from student most said is not applicable with the amount 25.8%

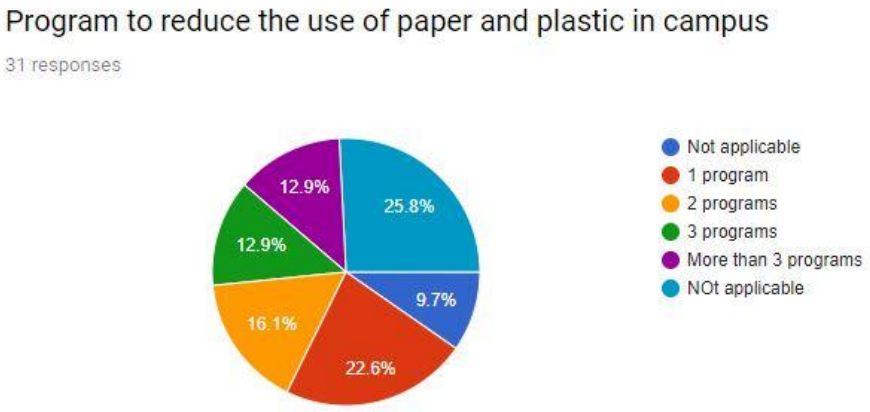


Figure 2. Program to reduce the use of paper and plastic in campus

and the rest said there still some programs exist to reduce the use of paper and plastic in campus.

Mostly organic waste consists of food which came from student and staff of campus. The responded said 32.3% no treatment for organic waste or the waste just thrown up to the place, simply said open dumping. 12.9% extensive.

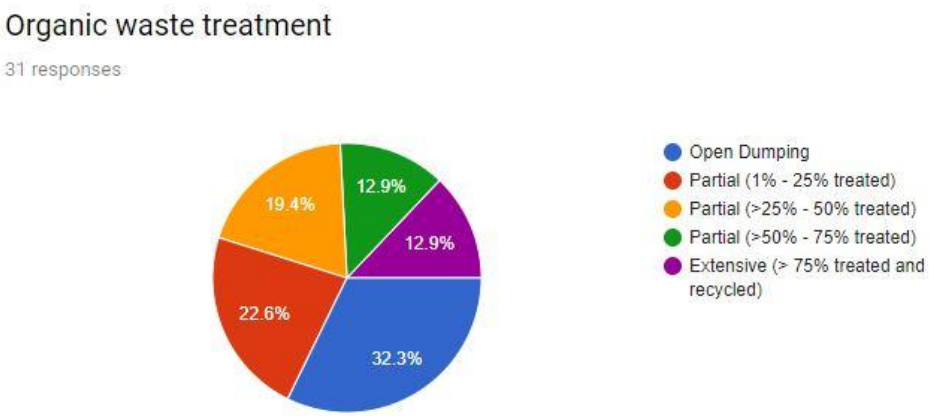


Figure 3. Organic waste treatment

Inorganic waste mostly consists of plastic and polythene, commonly people consume. Have a same result with organic waste, 29% respondents said no treatment, the operator just burned it in open condition. There same number between partial (1% - 25% treated) and extensive (>75% treated and recycled, the number 20% for each.

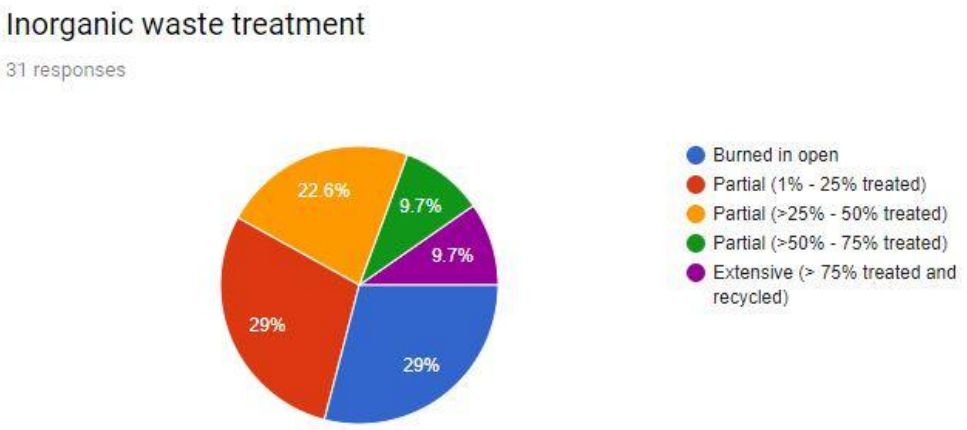


Figure 4. Inorganic waste treatment

Toxic waste consists of several chemical that have potential effect to human health. But it is a pity that 42.5% of respondents said, there's no management treatment to toxic waste.

Based on the knowledge about the campus, 38.7% agreed that sewerage disposal is treated technically, but close to previous 35.5% agreed sewerage disposal is untreated into waterways. The rest agree the sewerage is treated conventionally and just a pieces respondent said the sewerage is treated for cycling.

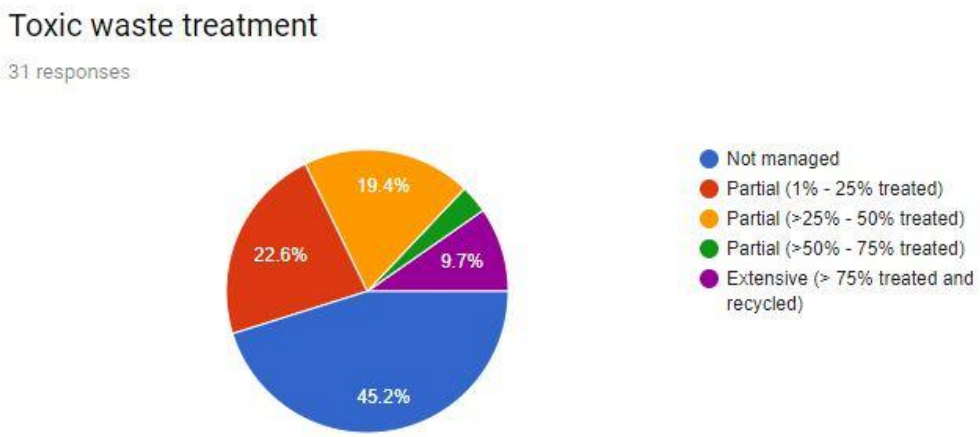


Figure 5. Toxic waste treatment

Another collection data we did interview to the operators and staff that responsible to the waste. According the result from interview, President University just disposed the waste without any treatment, said the operator. The parties from President University do not know where their waste ends, which they know only collects waste and will be given to vendors, Sir Iwan Bin Aca as the vendors.

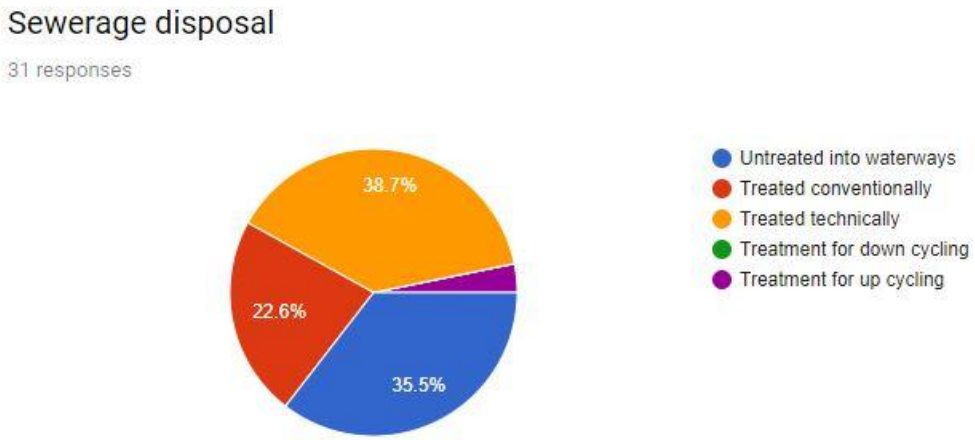


Figure 6. Sewerage disposal

We calculated in one day the average waste for Building B only produce 8 big polybag with the collecting time 1.30 pm and 9.30 pm. The vendor will took the waste 3 times in a week (Monday, Wednesday and Friday) with the cost 2,632,000,00- Rupiah in a month. The **table 1** shown consideration for the cost of disposal waste.

Table 1. The cost of waste disposal

Cost in one times pickup	Pickup quantity in a month	Cost in a month
Rp 2,632,000	1 time	Rp 2,632,000
	Total in a year	**Rp 31,584,000**

Discussion

Waste criteria standard according to UI GreenMetric have six indicators, as the point of the form. University sued to concern in waste treatment, but we see from the result in average number close to a half percent the waste in President University untreated, or we said un-properly treatment.

Actually data we use is an assumption from students where is based on the knowledge of each student. In solution President University needs to increase the awareness of academic community about their waste and improve the technology in waste treatment in order to meet the indicators issued by UI GreenMetric ranking. To meet the criteria and indicators of waste, university should make a recycling program, following principle green movement 3R (Reduce, Recycle and Reuse). Start to use sustain material then, university waste could be more effective and efficient. To strengthen its foundation, university can establish regulation regarding sustainability campus material, so that can implement 3R. The regulation must be followed for all academic community.

The lack infrastructural facilities and limited resources have caused waste not to effectively serve the universities for the treatment and disposal of solid waste, and most of academic community proper chose waste disposal treatment. By this problem must be start from university to give education to the community so can shared the awareness in campus environment. From the experience President University has many of events, even it's a major event, campus event, or community event, not often they consumed single used

property for decoration. Food also consideration in this problem, because most event they consumed drinking water glass and the packaging of the food consumed plastic.

In order to meet criteria and indicators several methods could be the program in university, waste reduction at source level and scientific methods of SWM. There are scientific methods of SWM (Solid Waste Management) waste stream segregation, composting and biogas extraction of organic wastes, recycle of paper, plastic and metal wastes, and incinerator of hazardous waste (Rajamanikam, 2014).

Waste stream segregation

Honestly before the latest canteen there was waste segregation. University provides three characteristic of waste, and then customer should put the waste compatible to the bin. But for the latest canteen there is no waste segregation. Besides the infrastructure for the waste, habit of community contribute big influence. Even the university gave the facilities but the community has not awareness, it's useless. Education is still number one to improve the environment of university. Together should change the perception of community to participate in waste segregation movement.

Composting and biogas extraction of organic waste

Following the result, 40% of student said the organic waste untreated and dispose in open dumping. As we know open dumping may cause potential health impact to human life. The solution we can do composting and biogas extraction.

UGM has implemented 2 type of technology such as compost or indore heap, and windrow composting using indore heap take method takes 60 days, for windrow composting takes 45 days process. Nevertheless windrow composting takes a shorter processing time, but has its deficiencies. Compared with indore heap, windrow method have not a leachate water treatment during the composting process. So, it is make leachate have to back to the heap with leachate flow into the container so the nutrients that contained in leachate water isn't wasted.

Vermicompost is an alternative method, a product of composting process using various species of worms, to create a mixture of decomposing vegetable or food waste. This method has shorter processing time rather than windrow composting, that is 30 days. Vermicompost method will produce compost can be used for plant fertilizer (Setyowati, 2018).

Recycle of paper, plastic, and metal wastes

Recycling is clearly a waste-management strategy, but it can also be implemented in industrial ecology, where the concept of industry is in natural ecosystem and no waste come up from product.

Easy step for recycle waste from reuse as long as the goods in good condition and try to use it. But it cannot be easy if the individual lacks awareness and care. In order to engage and to enhance academic community recycling behavior used an effective tool like share the information of recycling in terms of feedback, publicity, promotion, or a well-designed communication so the community interest to participate in recycle movement (Zhu, 2016).

Incineration of hazardous waste

Basically hazardous waste is very dangerous for human health. It make hazardous waste must be treatment properly, or it will give nor chronic or acute impact to human health.

During incineration of hazardous waste produce another waste like fly ash and bottom ash. There was a study about reused from fly ash and bottom ash to be secondary building material. Its mixture using Municipal Solid Waste Incineration (MSWI) bottom ash (BA) and air pollution control fly ash (Valle-Zermeno et al,).

Researcher from Spain has proved that from mixturing MSWI bottom ash with air pollution control fly ash can be secondary building material which also considered for the cost, this a sustainability program.

CONCLUSION

In Order to build a sustain environment regarding global warming that has given an impact, climate change. Green campus is an effort for sustain in campus environment, several university in Indonesia has a green campus based on their criteria but with several classification principal of green campus need to be fulfilled. Universitas Indonesia is a university that initiative to make an international green campus organization is UI GreenMetric World Ranking University. President University is participant of the organization regarding to green campus, which mean President University must follow the standard of UI GreenMetric in six indicators. Waste as the criteria on this journal have six indicator. The result shown that President University is in the level still learning as participant of UI GreenMetric regarding the standard. President University needs to increase the awareness of academic community improve the technology of waste management to fulfill the standard of waste criteria, like more campaign about waste management, impact of high consume can increase waste. Other solution is technology of waste treatment, the technical of treatment should to be improved. Not only following the standard of UI GreenMetric but also for the health of environment.

ACKNOWLEDGEMENT

Thank you to the Almighty God in His guidance and wisdom because of the completion of this journal. We are also grateful to Miss. Ir. Temmy Wikaningrum, M.B.A, M.Si as the head of the Environmental Engineering study program who has guided us while working on the journal. And a lot of our gratitude goes to Mr. Rijal Hakiki, S.S.T., M.T. as a lecturer who has provided information about the material in the journal. Do not forget we also expressed our gratitude to the informants we were willing to interview. Last but not least thank you to all authors for this reference for all information.

REFERENCE

Ravesteyn, Pascal, Henk P, Joris M.. (2014). Smart Green Campus : How IT can Support Sustainability in Higher Education. *Pascal Ravesteyn*

Simangunsong, Tuani Lidiawati. (2017). Pengelolaan Sampah Kampus untuk Mewujudkan Kampus Berkelanjutan (Sustainability Campus). *Article DOI: 10.21070/prozima.v1i1.707*

Kulkarni, Ramesh. (2017). Awareness about green campus opportunities amongst the educational institutions of north Karnataka. *International Journal of Commerce and Management Research Volume 3; Issue 3 Page No. 79-82*

Pusdadi, Nenes Anggi, MIA W, M RANGGA S. (2016). Perbandingan Kendala dan Tantangan Penerapan Konsep Green Campus di Itenas dan Unpar. *Jurnal Online Institut Teknologi Nasional Vol. 2 | No. 2*

R. Rajanikam and G. Poyyamoli (2014), Towards Zero-Waste Campus: Compositional Analysis of Solid Waste at The Staff Quarters To Frame Inclusive Sustainable Campus Waste Management System, *IJIRSET (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 4 page 11258*

O. Adelene, Joanneke K (2016), The Importance of Specific Recycling Information in Designing a Waste Management Scheme, *MDPI Volume 1, Issue 2*

Valle-Zermeno, R. del, J. Formosa, J.M. Chimenos, M Martinez, A.I Fernandez, Aggregate Material Formulated with MSWI Bottom Ash and APC Fly Ash For Use as Secondary Building Material

UI GreenMetric World University Ranking. 2010; http://greenmetric.ui.ac.id

Setyowati, Mega, Arif Kusumawanto and Agus Prasetya. 2018. Study of Waste Management Towards Sustainable Green Campus in Universitas Gadjah Mada, *IOP Conf. Series: Journal of Physics*

Zhu, Ning. 2016. Impact of Communication Appeals on Recycling Behaviours Among Undergraduate Students, *Purdue e-Pubs*

Arthawidya, Jalu, Endro Sutrisno, Sri Sumiyati. 2017. Analisis Komposisi Terbaik dari Variasi C/N Rasio Menggunakan Limbah Kulit Buah Pisang, Sayuran dan Kotoran Sapi dengan Parameter C-Organik, N-Total, Phospor, Kalium dan C/N Rasio Menggunakan Metode Vermikomposing, *Jurnal Teknik Lingkungan, Vol.6, No.3*

Latimer, Geoff, 2015, The Health and Environmental Impact of Hazardous Wastes, *Ascend Waste and Environment Pty Ltd*

Yukalang, Nachalida, Beverly Clarke and Kirstin Ross, 2018, Solid Waste Management Solutions for a Rapidly Urbanizing Area in Thailand Recommendations Based on Stakeholder Input, *MDPI International Journal of Environmental Research and Public Health*

Riley, Keith and Professor William Powrie Freng, 2015, Recycling Household Waste, *Royal Academy of Engineering*

COMPARISON STUDY OF BOD & COD OF LEACHATE QUALITY (CASE STUDY IN AIR DINGIN LANDFILL AND JATIBARANG LANDFILL)

A.M. Al-Hadi[1], D.A. Lestari[2] and J.P. David[3]
Environmental Engineering President University
Jl. Ki Hajar Dewantara, Jababeka Education Park, Cikarang, Jawa Barat 17550
[1]aidahmaqbulah01@gmail.com, [2]dyah.ipa@gmail.com, [3]julioputra99@gmail.com

Abstract: Leachate is one of the products that produced by a landfill. Leachate is extremely potential to pollute the environment, such as soil, groundwater and surface water. Air Dingin and Jatibarang landfill have a treatment to treat the leachate produced by the landfill before it is discharged to the environment because it has to be in accordance with Regulation of Ministry of Environment and Forestry of Republic of Indonesia Number P.59/Menlhk/Setjen/Kum.1/7/2016 concern Leachate Standard Quality for Businesses and/or Activities of Landfill. The leachate management in Air Dingin Landfill is controlled landfill, while in Jatibarang landfill, the the leachate management is coagulation-flocculation system. COD and BOD contained in Air Dingin Landfill leachate is lower than Jatibarang Landfill. In order to make leachate more environmental friendly, some innovative methods for leachate management have been developed, such as biofilter, wetlands, coagulation-fluctuation, and electrocoagulation.

Keywords: (*Leachate, Leachate Quality, Leachate Management, Air Dingin Landfill, Jatibarang Landfill).*

Abstrak: Air lindi adalah salah satu produk yang dihasilkan oleh TPA. Air lindi sangat berpotensi mencemari lingkungan, seperti tanah, air tanah dan air permukaan. TPA Air Dingin dan TPA Jatibarang memiliki proses pengolahan lindi yang dihasilkan sebelum dibuang ke lingkungan karena harus sesuai dengan Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia No. P.59/Menlhk/Setjen/Kum.1/7/2016 tentang Baku Mutu Lindi Bagi Usaha dan/atau Kegiatan Tempat Pemrosesan Akhir Sampah. Metode pengolahan lindi di TPA Air Dingin adalah *controlled landfill*, sedangkan TPA Jatibarang adalah sistem koagulasi-flokulasi. COD dan BOD yang terkandung di dalam air lindi di TPA Air Dingin lebih rendah daripada TPA Jatibarang. Untuk membuat lindi lebih ramah lingkungan, beberapa metode inovatif untuk pengelolaan lindi telah dikembangkan, seperti biofilter, lahan basah, koagulasi-fluktuasi, dan elektrokoagulasi.

Kata Kunci: *(Air Lindi, Kualitas Air Lindi, Pengolahan Air Lindi, TPA Air Dingin, TPA Jatibarang).*

INTRODUCTION

Nowadays, landfills in Indonesia become the main problem on the environment of the city. In Indonesia, mostly, landfills only built for disposing of solid waste without noticing the management of the other products that are produced by landfill. Waste in the landfill will produce two products that possibly will pollute the environment, which is biogas and leachate (Mahyudin, 2017).

Leachate has the potential to pollute the environment. It can be a major pollutant in the river, which is the place where the leachate is discharged into. The hazard level of poisoning caused by waste depends on the type and characteristics both in the short and long term (Irhamn et al, 2017). Raghab et al (2013) stated that leachate has the potential to have a high metals concentration and it also has the possibility to contain some hazardous organic chemicals. It also contain pathogenic bacteria (Andesgur et al, 2014). The quality of leachate is very varied and fluctuating depending on a number of things such as the variation and proportion of the components of garbage being dumped, rainfall and season, age of landfill, operational patterns carried out, and sampling time (Malita et al, 2015). Therefore, leachate need to be treated until it can be safe to the environment.

Management of leachate in landfills in Indonesia has not been noticed well by the government, as the apparatus responsible for this. Management of leachate is one of the alternative way to make an integrated

waste management Leachate water that seeps into the soil can contaminate groundwater, causing soil pollution, groundwater pollution, and surface water pollution. Most landfills in Indonesia currently do not carry out leachate treatment, because they do not have the facilities. Therefore, the quality of the water is still not in accordance with the quality standards. Management of leachate is quite difficult because there are so many things that need to be considered, such as season, type of waste, and age of the landfill (Rezagama et al, 2016).

Ministry of Environment and Forestry of the Republic of Indonesia has stated a regulation concerning on leachate quality standard, which is the Regulation of Ministry of Environment and Forestry of Republic of Indonesia No. P.59/Menlhk/Setjen/Kum.1/7/2016 on Leachate Quality Standard for Business and/or Final Waste Processing Site Activity. All landfill in Indonesia should refer to and comply with that regulation, so the leachate that is produced by a landfill has a standard quality that is stated by the authorized apparatus.

Some researchers found some methods to treat leachate that is produced by landfill. The methods that are researched are biofilter (Said and Hartaja (2015), constructed wetlands (Fajariyah and Mangkoediharjo, 2017), chemical coagulation-flocculation (Rezagama, 2016), and electrocoagulation (Yakobus, 2018). These methods are researched to prevent negative impact to the environment. By using these methods, it is expected that the quality of leachate produced by a landfill can meet the quality standard as stated in the regulation.

MATERIAL AND METHODS

We took the data from a previous research journal which were from (Sari and Afdal, 2017) and (Rezagama et al, 2016). The specific locations of the research are in Air Dingin Landfill, Baringin Subdistrict, Kota Tangah District, Padang City and in Jatibarang Landfill, Kedungpane Subdistrict, Mijane District, Semarang City.

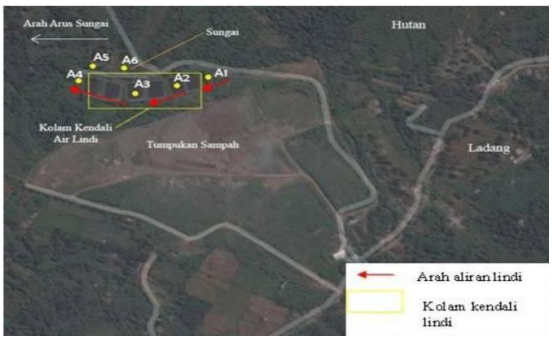


Fig. 1 Air Dingin Landfill Taken from (Sari and Afdal, 2017)

For the data collection of (Sari and Afdal, 2017), they take directly a sample from Air Dingin Landfill. The method that they use to collect data consist of:

1. Measure the pH value of each samples using a pH meter
2. Measure the value of electrical conductivity using a conductivity meter
3. Do the TDS test, TDS measurements are carried out by the gravimetry method
4. Then, the TDS value can be determined by:

$$TDS = \frac{B - C}{V} \times 100\%$$

5. Measure the COD and BOD values of leachate in the laboratory, followed by carried out for 6 test samples using the winkler titration method
6. Measure heavy metal content by using Atomic Absorption Spectrophotometry (AAS) in the laboratory (Sari and Afdal, 2017).

From (Rezagama et al, 2016), they take directly a sample from Wastewater treatment *Instalasi Pengolahan Limbah (IPL)* inlet in Jatibarang Landfill using the grab sampling method in accordance with (SNI 6989.59: 2008). The method that they use to collect data consist of:

1. Experiments using conventional jar-test equipment equipped with 6 glass 1 L alarms at room temperature

2. Stirring the samples was carried out in two stages, namely rapid stirring 180 rpm for 2 minutes followed by stirring slowly 40 rpm for 10 minutes. The deposition process lasts for one hour
3. Add coagulants used are Al_2 (SO_4) and $FeCl_3$ with the different dosage
4. Preliminary experiments show doses above 16 g/L decrease the efficiency of sediment removal.

In the preliminary test they get a wide range both of these values, where at the addition of 20 g/L there is an extraordinary formation of froth aluminum sulfate which affects the process. Some physical chemical parameters tested include TSS, BOD and COD in duplicate (Rezagama et al, 2016).

Fig. 2 Jatibarang Landfill
Taken from https://slideplayer.info/slide/12691369/

Leachate-precipitated leachate which has been precipitated is then separated from the water into a smaller glass beaker to make it easier to observe and test characteristics. It also aims to prevent re-mixing between deposits and the results of coagulation due to current movements sampling (Rezagama et al, 2016).

RESULT and DISCUSSION

The Temperature of Jatibarang and Air Dingin Landfill

The leachate temperature of Jatibarang landfill is 28.7^{o}C and in Air Dingin landfill which is 28.3^{o}C (Table 1). It is also known that sunlight has an important role for each leachate in both of landfills. And from government regulation LH P.59/2016 about leachate quality standard the value of temperature which is 38^{o}C. So, the leachate temperature of Jatibarang and Air Dingin landfill is below threshold Government regulation LH P.59/2016 about leachate quality standard.

Table 1. Comparison of Jatibarang and Air Dingin of leachate characteristic with Leachate Quality Standard

Parameter	Jatibarang Landfill	Air Dingin Landfill	Leachate Quality Standard (*)
Temperature (^{o}C)	28.7	28.3	38 *
pH	8.5	7.6	6 - 9*
COD (mg/L)	4000	246.3	300*
BOD (mg/L)	6000	127.1	150*

*) Government regulation LH P.59/2016 about leachate quality standard
Source : Rezagama, 2016; Sari and Afdal, 2017

pH Value of Jatibarang and Air Dingin Landfill

pH of leachate in Air Dingin landfill is 7.6, (table 1), and the pH of leachate in Jatibarang is 8.5 (table 1). From the government regulation LH P.59/2016 about leachate quality standard the value of pH which is 6 - 9. So, the pH leachate of Jatibarang and Sumur Dingin landfill is below threshold of Government regulation LH P.59/2016 about leachate quality standard.

COD (mg/L) of Jatibarang and Air Dingin Landfill

The value of COD leachate in Jatibarang is 4000 mg/L (table 1), which is higher than Government regulation LH P.59/2016 about leachate quality standard that has maximum COD value of 300 mg/L. Meanwhile, COD value of leachate from Air Dingin landfill is already in

accordance with the regulation, which is 246.3 mg/L (table 1).

BOD (mg/L) of Jatibarang and Air Dingin

The value of BOD leachate in Jatibarang which is 6000 mg/L (table 1) this value greatly exceeds the threshold from government regulation LH P.59/2016 about leachate quality standard with a value of BOD which is 6000 mg/L. And in Air Dingin landfill has the BOD value which is 127.1 it is mean that still on below from the leachate quality standard of Government regulation LH P.59/2016 about leachate quality standard.

RECOMMENDATION

To prevent the negative impact of leachate to the environment, there are some recommendation of methods to treat leachate before it is disposed to the environment. These are some methods that can be applied in leachate management.

Biofilter Process

Biological reactions generally use bacteria that have the ability to decompose pollutants. Biofilter is divided into two process which is aerobic and anaerobic process. Biological system can be are a good choice to treat wastewater, because it is safe, reliable, aesthetic and economic manner (Fuentes and Viscaino, 2018).

a. Aerobic Process

As the name suggests the process of leachate treatment with aerobic biological processes using oxygen. In this process, aerobic bacteria, organic pollutants, chemical compounds such as sulfides and ammonia will be described in this process so that when leachate is discharged into the environment it will be stable and safe.

As for the reaction that occurs in this aerobic process is (Said and Hartaja, 2015):

Organic pollutant compound $\rightarrow$ CO_2 + HO_2 + NH_4 + Biomass (1)

with Oxygen (O_2) and Heterotropic

As for nitrification correction as follows :

$NH_4+ + 1.5\ O_2 \rightarrow NO_2^- + 2H+ + H_2O$ (2)

$NO_2^- + 0.5\ O_2 \rightarrow NO_3-$ (3)

Sulfur oxidation reaction :

$S^{2-} + ½\ O_2 + 2H+ \rightarrow SO + H_2O$ (4)

$2S + 3O_2 + 2H_2 \rightarrow 2H_2SO_4$ (5)

For the oxygen that using in this reaction to mix with ammonia and sulfides and other organic the reaction its should equal to oxygen. And organic will be described became biomassa. And biomassa it can be sludge and the next process it is using another process.

b. Anaerobic Process

In the anaerobic process methane gas is obtained and almost all organic compounds are broken down into a single carbon compound.

during the decomposition stage, an acidification stage occurs which is the decomposition of acidogenic bacteria which hydrates the polymer compounds and converts them to organic acids . While in the next stage the gasification process will convert the results to methane as the final product (Said and Hartaja, 2015).

Organic decomposition reactions that occur in anaerobic processes as follows :

a. Hydrolysis and Acidogenesis

Complex organic pollutants will be hydrolyzed by hydrolase enzymes such as *lipase*, *protease* and *cellulose*. then this monomer will be broken down into fatty acids and hydrogen gas (Said and Hartaja, 2015).

b. The stage of formation of methane gas (*methanogenesis)*

For the first step to make methane gas which is acetic acid, H_2 and CO. And can be also from formic acid and methanol conversion.

$CH_3COOH \rightarrow CH_4 + CO_2$ (6)

$CO_2 + 4H_2 \rightarrow CH4 + H_2O$ (7)

$HCOOH \rightarrow 0.25\ CH_4 + 0.75\ CO_2 + 0.5\ H_2O$ (8)

The total of bacteria that using in this process greatly affect the decomposition of the pollutants above (Said and Hartaja, 2015).

Wetlands Process

Wetland is a process of vegetation which has a role in providing oxygen in the root zone, as a place for attaching bacteria and as an absorbent of pollutants in waste . Plants that can be used in the wetland process is *Cyperus papyrus* and *Canna sp.* During this process there will be a decrease in COD value and measurement of BOD, NTK, TP and TSS (Sembiring and Muntalif, 2011).

In the wetlands process, leachate is only put into the wetland and there will be a process inside which is then deposited. as for the duration of deposition depending on how much concentration in the leachate (Sembiring and Muntalif, 2011).

Landfill that has applied this method of leachate treatment is Chunchula Landfill, Mobil County, Alabama. The treatment system surrounds 1.29 Ha of surface-flow wetlands in the boundaries of the landfill. The system is designed to treat leachate and leachate-contaminated groundwater at hydraulic loading rate of 500 g/day. (Johnson et al, 1999)

Coagulation-flocculation Process

The coagulation flocculation process utilizes the coagulant properties to reduce the parameters of wastewater . In the coagulation process there will be a process of deposition of particles halu normally using bantual from Earth's gravity so that it becomes a larger particle. While the flocculation process is the process by which suspended particles are stirred slowly to make a larger flock than before. and than is deposited again. after that, there is a process of separation and eliminating pathogenic microorganisms in water. FeCl3 can be used in this process to increase degradable leachate (Prabowo et al, 2017).

Landfill that has applied this kind of leachate treatment is Hamadan Landfill, Iran. In the study of the method that has been applied, it shows the efficiency of COD removal is 60% until 70% and TSS removal is 39% until 55% (Samadi et al, 2010).

Electrocoagulation

Electrocoagulation is a process that uses electrodes to supply ions to the solution, so that contaminants that are emulsified, dissolved and solid form agglomerates (Yakobus, 2017).

There are several stages in this process, which are: Coagulant formation from electrilot oxidation. Furthermore, destabilization of contaminants and particulate suspensions and breakdown of emulsions. and finally aggregation from the destabilization phase to form flocs. Contaminated solutions are handled by chemical reactions and precipitation and attachment of chemicals into the coloid material produced by the electrode. these particles can be separated by sedimentation or the electroflotation then attaches to the H_2 bubble changing at the cathode (Yakobus, 2017).

As for the potential series known to be reduced more easily, namely: K. Ba, Ca, Na, Mg, Zn, Al, Cr, Fe, Cd, Co, Ni, Sn, Pb, Sb, Bi, Cu, Hg, Ag, Pt, Au. of the many metals, which are very easily oxidized are Al (Yakobus, 2017).

Landfill that has applied electrocoagulation method to treat their leachate is a landfill in Bagalkot Town, India. The method is successfully removed the polluting parameters, such as COD, color, and turbidity with efficiency up to 92.1%, 94% and 95.5% respectively when the leachate is treated for 35 minutes and

with DC power supply 9V (Shivayogimath and Watawati, 2014).

CONCLUSION

Because the treatment of leachate in Air Dingin Landfill and Jatibarang Landfill for the level of BOD, COD, pH, and temperature are still not in accordance with the regulated law. Some researches of leachate treatment, such as biofilter, wetlands, coagulation-fluctuation, and electrocoagulation (as explained in the recommendation) showed that those methods can be a good method to treat leachate. It is highly recommended for all landfill in Indonesia to treat leachate with those methods.

REFERENCE

Andesgur, I. Hakim, L. Julianto, T. S. 2014. Pengolahan lindi (leachate) dari TPA dengan proses elektrokoagulasi - sedimentasi dan filtrasi. Jurnal Sains dan Teknologi 13(1): 28-34.

Fajariyah, C. Mangkoedihardjo, S. (2017). Kajian Literatur Pengolahan Lindi Tempat Pemrosesan Akhir Sampah dengan Teknik Lahan Basah menggunakan Tumbuhan Air.

Fuentes, N. and Viscaino, L. Y. 2018. Integrated system biodigester biofilter a sustainable option for the environmental management of wastewater from small communities. Contemporary Engineering Sciences 11(87): 4329-4337.

Ganefati, Sri Puji and Susanto, Joko Prayitno. (2015). Pengolahan Lindi (Leachate) Dengan Model Coagulation - Biofilter Anaerobic. Jurusan Kesehatan Lingkungan, Poltekkes Depkes Yogyakarta Peneliti di Pusat Teknologi Lingkungan- BPPT

Irhamni. Pandia, S., Purba, E., and Hasan, W. 2017. Kandungan Logam Berat pada Air Lindi Tempat Pembuangan Akhir (TPA) Sampah Kota Banda Aceh. Tesis. Pascasarjana Unsyiah.

Johnson, K. D., Martin, C. D., Moshiri, G. A., and McCrory, W. C. (1999). Constructed Wetlands for the Treatment od Landfill Leachates Chapter 5. Lewis Publishers, New York.

Malita, Y. A. Ratnawulan. Mufit, F. (2015). Karakterisasi Mineral Magnetik Lindi (Leachate) TPA Air Dingin Kota Padang Menggunakan Scanning Electron Microscopice (SEM). Pillar of Physics 5: 81-88.

Prabowo, Z. N. Rezagama, A. Hadiwidodo, M. 2017. Pengolahan air lindi menggunakan metode koagulasi flokulasi dengan kombinasi biokoagulan sodium alginat - koagulan Al2SO4 dan Advanced Oxidation Processes (AOPs) dengan fenton (Fe/H2O2). Jurnal Teknik Lingkungan 6(1): 1-13.

Raghab, S. M. Meguid, A. M. A. E. Hegazi, H. A. 2013. Treatment of leachate from municipal solid waste landfill. HBRC Journal 9: 187-192.

Rezagama, A. (2016). Penyisihan Limbah Organik Air Lindi TPA Jatibarang Menggunakan Koagulasi-Flokulasi Kimia. Teknik 37(2): 78-83.

Said, I. N. and Hartaja, D.R.K (2015) Pengolahan air lindi dengan proses biofilter anaerob-aerob dan denitrifikasi. Pusat Teknologi Lingkungan, BPPT.

Samadi, M.T., Saghi, M. H., Rahmani, A., Hasanvand, J., Rahimi, S., Shirzad, S.M. (2010). Hamadan landfill leachate treatment by coagulation-flocculation process. Iranian Journal of Environmental Health Science and Engineering. 7. 253-258.

Sari, R N. Afdal. (2017) Karakteristik Air Lindi (Leachate) di Tempat Pembuangan Akhir Sampah Air Dingin Kota Padang. Jurnal Fisika Unand 6(1): 93-99.

Sembiring, E. T. J. and Muntalif, B. F. (2011). Optimization of Leachate Treatment Efficiency by Using Constructed Wetland. Jurnal Teknik Lingkungan 17(2): 1-11.

Shivayogimath, C. B. and Watawati, C. (2014). Landfill Leachate Treatment by Electrocoagulation Process Using Iron Sacrificial Electrodes. International Journal of Renewable Energy and Environmental Engineering 2(3).

Yakobus, A. M. (2017). Penanganan Lindi Dari Tempat Pembuangan Air Dengan Proses Elektrokoagulasi. Journal from open access source: zenodo.org

Journal of Environmental Engineering and Waste Management

Dewan redaksi menerima tulisan ilmiah yang merupakan karya orisinil penulis yang dapat berupa hasil penelitian, rekayasa atau telaah ilmiah di bidang keteknikan lingkungan, pengelolaan lingkungan, ilmu lingkungan dan pengelolaan limbah. Penulisan karya ilmiah yang akan diterbitkan mengacu pada aturan penulisan sebagai berikut :

1. **Judul *(Title)***. Judul ditulis dengan huruf kapital dalam bahasa Indonesia atau bahasa Inggris dalam kalimat lengkap secara jelas dan singkat. Judul menggambarkan apa yang menjadi pokok dalam tulisan. Penulisan dengan font Times New Roman ukuran 14.
2. **Nama Penulis *(Author[s])***. Nama penulis ditulis dibawah judul secara lengkap tanpa menuliskan jabatan, struktural/fungsional ataupun gelar. Diikuti dengan menuliskan instansi serta alamat yang jelas untuk setiap penulis, termasuk e-mail. Penulisan dengan font Times New Roman ukuran 10 dengan jarak 1 spasi**.**
3. **Abstrak *(Abstract)***. Abstrak ditulis dalam bahasa Inggris dan bahasa Indonesia (masing-masing dalam 1 paragraf). Abstrak mencakup apa yang dilakukan, bagaimana cara melakukannya, hasil yang diperoleh, serta informasi apa yang merupakan paparan dari hasil tersebut. Abstrak ditulis dengan Times New Roman ukuran font 10 dengan jarak 1 spasi, diikuti oleh kata kunci *(keywords)* 3-5 kata ditulis miring *(italic)*. Kata kunci ditulis secara alfabetis.
4. **Pendahuluan *(Introduction)***. Pendahuluan merupakan latar belakang serta permasalahan yang menjadi perhatian serta tinjauan ringkas tentang hal tersebut, boleh diisi dengan teori yang ringkas bila memang sangat menentukan dalam pembahasan (ditulis dengan jarak 1 spasi).
5. **Bahan dan Metode *(Materials and Methods)***. Tuliskan semua bahan, peralatan dan metode yang digunakan dalam penelitian/rekayasa mengikuti peraturan umum penulisan secara jelas dan ringkas).
6. **Hasil dan Pembahasan *(Results and Discussion)***. Hasil penelitian ditampilkan dalam bentuk tabel atau gambar dan harus dirujuk dalam pembahasan. Penomoran tabel dan gambar dilakukan secara berurutan dimulai dari nomor 1 dan seterusnya. Judul tabel/gambar ditulis dengan Times New Roman, ukuran huruf 10, spasi 1. Data dalam bentuk foto agar dikirim dengan resolusi tinggi. **Gambar, Grafik dan Diagram**. Keterangan gambar grafik dan diagram ditulis di bawahnya. Nomor gambar dicetak tebal (bold) sedangkan keterangannya normal. **Tabel**. Keterangan tabel ditulis di atas tabel (center alignment). Nomor tabel dicetak tebal (bold) sedangkan keterangan/judul tabel normal.
7. **Kesimpulan *(Conclusion)***. Suatu ringkasan menyeluruh dari semua aspek hasil penelitian yang berkaitan langsung dengan tujuan penelitian. Ditulis dalam satu paragraf.
8. **Ucapan terima kasih *(Acknowledgment [s])***. Disampaikan kepada yang berhak mendapatkannya, seperti penyandang dana, pihak yang membantu dalam penelitian ataupun penulisan serta narasumber/perorangan yang dipandang layak dihargai (opsional).
9. **Daftar Pustaka *(References)***. Daftar pustaka ditulis dengan font Times New Roman ukuran 10 dengan jarak penulisan 1 spasi berurutan mulai dari nomor 1 dan seterusnya sesuai dengan urutan kemunculannya pada sitasi/pengacuan dalam tulisan (pendahuluan sampai dengan hasil dan pembahasan).
   - Apabila yang diacu adalah buku maka ditulis secara berurutan : Nama penulis (nama penulis yang pertama dibalik posisinya kemudian diikuti nama penulis kedua dan ketiga). (Tahun Terbit). *Judul Buku.* Edisi Terbitan. Tempat Terbit : Penerbit (Contoh : Sawyer Clair N, Mc Carty Perry L. and Parkin Gene F. (2003). *Chemistry for Environmental Engineering and Science*, *Fifth Edition*. Boston : Mc Graw Hill
   - Apabila yang diacu artikel dalam jurnal maka ditulis secara berurutan : Nama Penulis. (Tahun Terbit). *Judul Jurnal.* Jilid diikuti nomor jurnal : halaman (Contoh : Rytwo, G. (2012) The Use of Clay-Polymer Nanocomposites in Wastewater Pretreatment. *The Scienific World Journal*, 71 (12) : 48-60).
   - *Et al*. hanya berlaku bila penulis lebih dari 11 orang.
10. **Cara Penulisan Sitasi *(Citation)***. Penulisan sitasi pada awal kalimat mengikuti : Menurut Sidjabat (2013), ... atau diakhir kalimat : .....(Sidjabat 2013)
11. Jumlah halaman minimal 7 dan maksimal 12 halaman A4 termasuk lampiran-lampiran. Seluruh isi artikel ditulis dalam font Times New Roman ukuran 12 dengan jarak penulisan 1 spasi. Semua judul bab ditulis dengan huruf kapital. Naskah ditulis dalam 2 kolom.

Journal of Environmental Engineering & Waste Management
Jurnal Teknik Lingkungan dan Pengelolaan Limbah

Vol. 4 No. 1 April 2019 ISSN 2527-9629

Making and Testing Sample Control on Determination of Nitrite Content in Water and Wastewater By Using UV-Visible Spectrophotometer 1-8
(E. Styani, E. Sri Lestari, I. Widiana, M. Ramadhan)

Pengembangan Model Pemilihan *Green Supplier* di Kawasan Industri Cikarang 9-20
(Filson Maratur Sidjabat, Johan Krisnanto Runtuk)

Pemanfaatan Limbah Organik Berbasis *Bio Cyclo Farming* (Studi Kasus di Desa Telaga Murni) 21-27
(Hiqmatus Sholichah, Annisa Nur Wahyuni)

The Academic Community Perseption About Implementation of UI GreenMetric-Waste management Criteria at President University 28-36
(Kezia Kusumaningtyas, Ramadani Fithratullah, Clara Meluk)

Comparison Study of BOD & COD of Leachate Quality (Case Study in Air Dingin Landfill and Jatibarang Landfill) 37-42
(Aidah M. Al-Hadi, Diah A. Lestari, Julio P. David)

Journal of Environmental Engineering & Waste Management
Jurnal Teknik Lingkungan dan Pengelolaan Limbah

Building A Lt. 3 President University, Faculty of Engineering
Jl. Ki Hajar Dewantara, Jababeka Education Park, Cikarang Baru,Bekasi 17550 – Indonesia
Phone./Fax: (021) 8910 9762 / 9768; Email: j-env@president.ac.id
Website: env.president.ac.id (President University: www.president.ac.id)