International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: http://doi.org/10.31695/IJASRE.2018.32853

Volume 4, Issue 8
August - 2018

Strategy for Sustainable Solid Waste Management in Central Java Province, Indonesia

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ABSTRACT

This study aims to determine the best strategy for sustainable solid waste management in Central Java Province, Indonesia. A well-managed waste will deal with current and future waste problems. The Analytical Hierarchy Process (AHP) is used to assess and structure the views of the key person. Super Decisions software is used for the purposes of the analysis. The assessment revealed that recycling is the best strategy for managing sustainable solid waste in Central Java Province with reference to economic aspects, environmental aspects, social aspects and technological aspects.

Keywords: *Strategy, Waste management, Solid waste, AHP, Recycling*

1. INTRODUCTION

Waste management is everything that concerns people's choice to manage useless goods. Ideal waste management is a zero waste with the right strategy that can be applied indefinitely, by changing waste physically and chemically so that it becomes a valuable item again as well as raw material for new products [1].

Waste management as one of the most complicated and costly forms of public services [2]. If there is a failure in managing waste, it will cause health and environmental problems. Good waste management depends on differences in structure, economy and social conditions in each region [3].

Implementation of solid waste management in developing countries is very important considering that waste always arises with increasing urbanization and population growth. Waste management must be carried out properly because it relates to public health and environmental problems [4]. Waste management requires a strategy by forming a comprehensive hierarchy of waste management [5]. The hierarchy of waste management helps waste management from planning to the concept of waste management that is more environmentally friendly until the final processing so as to produce minimal waste [6].

Conventional solid waste management is usually done in many developing countries, especially in the Asia and Pacific region, where waste only moves from waste sources to landfill. Garbage is not managed in advance from the source. As a result, garbage in the landfill accumulates. Waste that is only stacked in the landfill will have the potential to cause environmental pollution [7] and cause illness [8].

Indonesia, as one of the developing countries, seeks to overcome the ever increasing solid waste. The Government of Indonesia issued Law Number 18 of 2008 concerning Waste Management and Government Regulation of Republic of Indonesia Number 81 of 2012 concerning Household Waste Management and Household-like Waste, explained that the activities of waste reduction and handling of garbage must be carried out by all levels of society in a gradual and planned manner and based on clear policies and strategies. Then through the Minister of Home Affairs Regulation No. 33 of 2010 concerning Waste Management Guidelines, which states that in the context of handling waste in a comprehensive and integrated manner, it is necessary to involve the participation of the community and the business world proportionally, effectively and efficiently.

Indonesia consists of 34 provinces. One of the provinces is Central Java. The efforts of Central Java Province in realizing a healthy, beautiful and clean area of waste, then waste management must be carried out comprehensively and integrated from upstream to downstream to provide economic benefits, be safe for the environment, and can change people's behavior. Waste

management is the responsibility of all stakeholders. Referring to Law Number 18 of 2008, the Governor of Central Java as the Head of the Central Java Province, made the Central Java Regulation No. 3 of 2014 concerning Waste Management in Central Java, adjusted to the conditions in each region. In accordance with this, the regional ggovernment has the duty to guarantee the implementation of good and environmentally sound regional waste management.

Waste management in Central Java has not been as expected. The waste that is capable of being managed by city districts in Central Java is only around 5%, and those transported to the landfill are 11% [9]. Therefore, the right strategy is needed to overcome this. Central Java Province has the capital city of Semarang City. Central Java Province consists of 35 districts/cities, namely 29 regencies and 6 cities. Its area reaches 3.25 million hectares and its population reaches 33 million people.

About 47,000 tons of garbage per day in Central Java are not transported. Whereas waste that has been transported to the landfill is only stacked without further management. Waste management at the landfill is operated by open dumping [10]. This condition will be dangerous in the because the age of the land will decrease. The landfill operation is suggested by the law is a sanitary landfill, and this method requires extensive land and cost [11]. Therefore, a strategy is needed to deal with the source to the final stage, with good synergy between the government, the private sector and the community [7].

2. MATERIALS AND METHODS

This study uses primary data involving nine key persons are selected according to the capacity of each (purposive sampling). This key person is environmental experts and observers. Experts and environmentalists answer questions that have been prepared to choose a waste management strategy in Central Java, as part of the AHP method. AHP method is a decision making technique that is often used to solve complex problems from various disciplines. AHP was developed by Thomas Saaty in the 1970s. AHP is a decision-making system using a mathematical model [12].

[12] states that the AHP method is a tool used to determine the influence of an element on a problem, through a comparison scale compared in pairs to several elements. AHP organizes goals, criteria, sub-criteria and alternatives that are arranged in a hierarchical structure. AHP is based on reciprocal comparison, homogeneity, stand-alone and hope.

The steps of choosing a policy alternative by using AHP are (1) building a hierarchical structure to decide criteria, sub-criteria and alternatives, (2) determining priorities arranged in pairs on relative and sub-criteria, (3) Estimating relative weights with eigen values which shows the importance of criteria and sub criteria, (4) Determine the consistency index and consistency ratio. The comparison matrix in AHP will be accepted if the consistency ratio is less or equal to 10% ($CR \leq 0{,}10$) [13].

Table 1. Pairwise Comparison Matrix Scale

Interest Intensity	Definition
1	Equal Importance
3	Moderate More Importance
5	Essential, Strong More Importance
7	Demonstrated Importance
9	Absolutely More Importance
2,4,6,8	Values Between Two Close Considerations
Opposite	If For Activity I Gets One Number When Compared To Activity J, Then J Has The Opposite Value When Compared To I.

Source: [13]

Pairwise comparison is presented in the form of a matrix, for example with matrix A and the matrix element is a_{ij} , where factor i is relatively important compared to factor j, so it can be calculated as follows :

DOI: 10.31695/IJASRE.2018.32853

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (1)$$

The number of cells in the paired assessment matrix is n (n-1) / 2. Assessment of paired comparisons based on Table 1 applies the law of reciprocal axioms, for example element A is more important with value 3 with element B, then element B is more important 1/3 compared to element A. If element A is as important as element B, then each element is worth 1 [14].

Estimating relative weights with eigen values that indicate the importance of criteria and sub criteria [14]. Determination of the weight carried out by the key person according to the questionnaire. The weight that is searched is expressed in the vector w = (w_1 , w_2 , ..., wn), so the eigen vector is:

$$AW = \begin{pmatrix} a11 & a12 & \dots & \dots & a1n \\ a21 & a22 & \dots & \dots & a2n \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ an1 & an2 & \dots & \dots & ann \end{pmatrix} \times \begin{pmatrix} w1 \\ w2 \\ \dots \\ \dots \\ wj \end{pmatrix} \quad (2)$$

While the *eigen value* is

$$\lambda \max = \frac{1}{n} \sum_{wi}^{n} \frac{(AW)i}{wi} \quad (3)$$

Determine the index of consistency and consistency ratio. The consistency indicator is measured through a consistency index with the following formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (4)$$

where CI is the *consistency index* , λ max is the maximum *eigen value* and n is the matrix size.
Ratio consistency with the formula:

$$CR = \frac{CI}{RI} \quad (5)$$

where CR is *consistency ratio* , CI is *consistency index* and RI is *random index* . The *random index* value is presented in table 2 below:

Table 2. Matrix Size and Random Index

Matrix Size	*Random Index* (RI)
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: [13]

The comparison matrix in AHP will be accepted if the consistency ratio is less than or equal to 10% (CR ≤ 0.10)

III. RESULTS AND DISCUSSIONS

The AHP structure enables decision makers easily and can determine the choice of strategies offered to overcome problems in accordance with the criteria and sub criteria that are elevated. Therefore, experts are needed who can make decisions based on their knowledge and experience [15].

The waste management hierarchy is as follows:

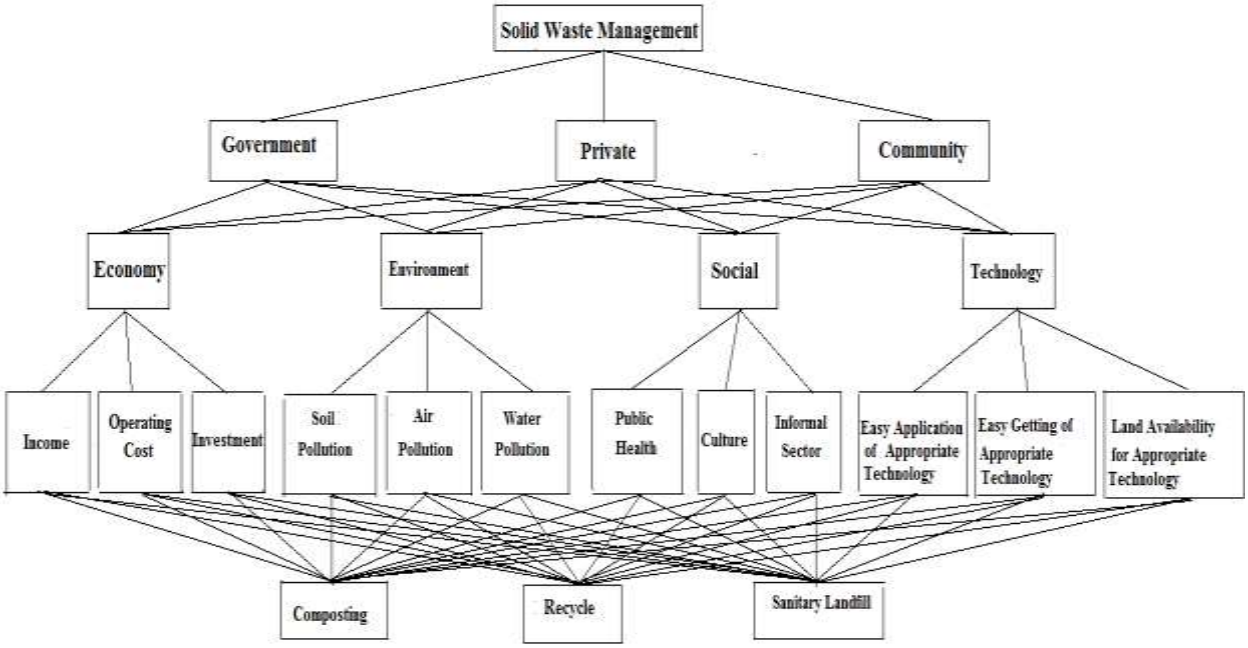

Figure 1 . Hierarchy of Sustainable Solid Waste Management Strategies

In accordance with the hierarchy presented in Figure 1, the hierarchy in this study begins with the goal of waste management. Waste management is the activity of transporting waste from waste sources to final processing at the landfill. Actors who do waste management are the government, the private sector and the community. The government, in this case, is the agency that is given the authority to manage waste. The sector is an industry that does waste management. Society is a household and community institution. The next hierarchy is the criteria covering economics, environment, social and technology. Economic criteria related to waste management require costs and generate income. Economic criteria consist of operational costs, investment and income. Operational costs are costs that arise from transporting waste to processing waste at the landfill. Investment is the investment needed in waste management at the final level. Revenue is income derived from waste management.

Environmental criteria related to pollution that can be caused if the management is not good. Environmental criteria include water pollution, soil pollution and air pollution. The next criterion is the social criteria. The social criteria relate to social problems of waste management, which include the culture of the community in managing waste, available jobs in waste management activities, and the health of the community in accordance with the waste management carried out. The next criteria are technological criteria. Technological criteria related to land, ease of access and ease of application of technology used in managing waste.

Based on these criteria, then there are alternative strategies that include composting, waste recycling and sanitary landfills. Composting is composting organic waste. Waste recycling is the activity of converting inorganic waste into useful and selling valuable items on a household scale. Sanitary landfill is the processing of waste in the landfill by removing and stacking waste to a sunken location, compacting the waste and covering it with soil, then so that the waste leachate does not pollute the water source so there is a geomembrane to localize the leachate. Leachate is treated first before being disposed of. Whereas methane gas from the waste decomposition process can be channeled through pipes. This methane gas can be used for cooking or electricity generation. So that sanitary landfills require large areas and are costly, but sanitary landfills are final waste processing in accordance with the law.

DOI: 10.31695/IJASRE.2018.32853

This study uses SuperDecisions as a tool to process AHP in order to choose a sustainable waste management strategy. The AHP method consists of three phases is model construction that can be obtained from the literature study, model quantification is by compiling a paired questionnaire on the levels in the hierarchy that are used, the analysis of results that is validating and interpreting the answers experts.

The hierarchy of waste management strategies is adapted to the study of literature and informal interviews with environmental observers, namely academics, government authorities in managing waste in Central Java, and non-governmental organizations. The choice of this strategy determines sustainable waste management that is adapted to the conditions of the district/city in Central Java. The waste management strategy consists of composting, recycling and sanitary landfill.
The strategy chosen is carried out by actors as waste managers. In addition, the strategy is based on economic, social, technological and environmental criteria. Each criterion contains sub-criteria that also determine strategy. Economic criteria consist of sub-criteria for national income, operational costs and investment. Social criteria consist of sub-criteria for public health, culture and the informal sector. Environmental criteria consist of sub-criteria of pollution, soil pollution, air pollution. Technology criteria consist of sub-criteria for the application of appropriate technology, ease of access to appropriate technology, availability of land for appropriate technology.

The research model is based on waste management institutions, namely the rules that underlie waste management in Central Java and adhered to by waste management stakeholders. The research model to determine the best waste management strategy in Central Java is a unity or integration between waste management actors to manage waste based on specified criteria and sub criteria. After creating a construction model, the next step is to arrange questions in pairs at each hierarchy level. If paired questions have been arranged, then the priority or weight of each cluster element and inconsistency index will be obtained. The tools for the analysis needs used are Super decisions. The results of the analysis are presented in Table 3 below:

Table 3. Ranking of Hierarchical Elements

Clusters	Cluster Elements	Priority (Weight)	Rating
Actor	Community	0.16258	2
	Government	0.72858	1
	Private	0.10884	3
Criteria	Economy	0.22024	2
	Environment	0.6139	1
	Social	0.09693	3
	Technology	0.06886	4
Environment	Water pollution	0.65736	1
	Soil Pollution	0.11125	3
	Air pollution	0.23139	2
Economy	Operating costs	0.24747	2
	Investment	0.57875	1
	Income	0.17378	3
Technology	Land availability for appropriate technology	0.27298	2
	Easy getting of appropriate technology	0.27185	3
	Easy application of appropriate technology	0.45517	1
Strategy	Recycle	0.54981	1
	Composting	0.22534	2
	Sanitary Landfill	0.22486	3

Based on Table 3, the main waste management is the government. H al is the mandate of Law No. 18 of 2008, that the government is obliged to manage waste as part of the task of structuring a city [16] Research [7] show that the role of government is very important in waste management. The role of the government, in this case, is as a provider of solid waste infrastructure, especially for developing countries [17]. However, the community and the private sector must still play an active role in managing

waste [18] .The community is even expected to manage waste from the source of waste, namely households [19]. Private companies such as companies are obliged to also reduce waste from packaging products produced and processed waste [20].

In addition to the assessment of the actors, the next assessment is about the criteria. As per Table 3, the environment is a priority criterion. This is consistent with the study of [15] that waste management is closely related to environmental problems. If waste is not managed properly, environmental quality will decrease [8]. However, waste management is an integrated activity, considering that waste is a complex problem [21]. All aspects involved in waste management are management, cultural, political, social, environmental, economic and institutional techniques as well as optimal combinations of methods of prevention, reduction, recovery and disposal by involving *stakeholders* so that waste problems can be solved from upstream to downstream [16].

Waste problems are closely related to environmental problems. Environmental criteria in this study are water pollution, air pollution and soil pollution. In accordance with Table 3, water pollution is a priority for environmental criteria. According to [15] that waste that is disposed of carelessly or garbage that is disposed of in the landfill without being managed further will make it possible to cause water pollution. This happens because the slippery water that comes out of the natural process of garbage decay is not accommodated so it will enter the nearest water source or the nearest water channel.

This condition usually occurs in the landfill where waste management uses an open dumping system. According to [10], there are still many waste management in Central Java that operates using open dumping systems. In accordance with Law No. 18 of 2008 concerning Waste Management, this system has actually been banned. However, this system was chosen because it is low-cost compared to the high-cost sanitary landfill system, although open dumping has a consistency that can cause water pollution. The middle road chosen by the district/city for final processing in the landfill is controlled landfill, where waste that has been transported to the landfill periodically will be compacted and then filled with soil to avoid flies and odors.

The smell of garbage is one of air pollution. In accordance with Table 3, air pollution ranks second on environmental criteria. In addition to water pollution, an open dumping system in the landfill will cause odor. If the waste is burned conventionally, then, the burning of waste will produce carbon monoxide (CO), carbon dioxide (CO2), dioxin, benzopirene, particulates and others. The gas will cause air pollution because it will disrupt human health [7]. According to [22], an open dumping system in landfills can also cause air pollution and soil pollution. Soil pollution ranks third on environmental criteria based on Table 3. Waste that is difficult to decompose such as B3 waste, plastic, glass when directly stockpiled, liquid inorganic waste such as used oil, dirty water containing chemicals, and other household waste when disposed of directly to the soil without further treatment will cause the decomposing bacteria to die, so that these wastes can cause soil pollution [23].

In addition to environmental criteria consisting of water pollution, air pollution and soil pollution, waste management is also related to economic aspects. Economic criteria include operational costs, investment and income. Based on Table 3, the economic criteria that are ranked first are investments. This is because the ability of local governments is limited, so investment is needed both domestically and from abroad to help overcome solid waste problems [15]. The waste processing technology is difficult to be fulfilled by regions in Indonesia because it is very expensive, so investment is needed to process the waste [24].

Ooperational costs are also a separate obstacle in waste management. Based on Table 3, operating costs are ranked second on economic criteria. Operational costs are needed to manage waste from upstream to downstream. The operational costs include all costs incurred during garbage collection, garbage transportation and final processing at the landfill as well as maintenance of solid waste facilities and infrastructure [25]. To realize a zero waste condition, the consequences that must be borne are the emergence of high costs in waste management [7]. Operational costs play an important role in waste management, however, the operational costs of waste management in Indonesia are very small. Therefore, garbage in the city districts in Central Java has not been fully overcome properly.

The next ranking of economic criteria in accordance with Table 3 is income. Garbage is considered an economic resource that can increase income [15]. The income is in the form of profits from waste collection efforts and profits from waste recycling efforts where creativity in managing waste can foster creative industries that can sustain the national economy [26].

Waste management is also related to social criteria. Social criteria include public health, culture and the informal sector. Based on Table 3, the social criteria that are prioritized are public health. Waste that is not managed properly will have an impact on human health due to the heap of garbage as a source of transmission of diseases such as diarrhea, dysentery, malaria, tuberculosis and abdominal typhus [8]. Dirty environment as a good place for developing germs, therefore the concept of zero waste really must be implemented so that public health is maintained.

DOI: 10.31695/IJASRE.2018.32853

Disease spread from waste can be avoided, by increasing the culture of clean living. The culture of clean living is to carry out activities to dispose of trash in its place which must be continued. According to Table 3, culture occupies the second priority of social criteria. Efforts to improve the culture of clean living can be started from the household environment as well as from education. In accordance with [17], education can influence a person's behavior, including the behavior of throwing trash in its place, behavior of managing waste from the source and so on. With sufficient education, bad behavior towards the environment can be avoided [27]. However, in reality, the level of education in Central Java is low, where the average length of new schools reaches primary education [28]. This condition shows that knowledge of good waste management in Central Java is still lacking and clean living has not become a culture.
The level of education in Central Java is low, the available employment and in accordance with the educational background is the informal sector. Based on Table 3, the informal sector occupies the third priority of social criteria. This informal sector is in the form of collecting used goods and recycling waste that can create new jobs. The large volume of solid waste generation allows open business opportunities for collecting used goods and recycling waste [29]. This effort will succeed if businesses in this field know the marketing of their products [14], so that the goods marketed will sell and bring profits.

The next criteria related to waste management are technological criteria. In accordance with Table 3, the priority of technology criteria in the sequence is the application of appropriate technology, availability of land for appropriate technology, and easy to obtain appropriate technology for waste management. As present waste management technology is high technology and very expensive. So, that the city district is difficult to implement it [24]. But in the future, waste management requires simple technology and is easily applied by the community [30]. Besides being easy to implement, waste management technology requires land so that waste can be accommodated for further processing and does not disturb the surrounding environment [15]. Land for waste processing technology is important, considering that waste management technology requires large areas of land such as land used for sanitary landfills, land for incinerators and other technologies. The current condition of land is difficult to obtain, especially in big cities, so that's a lot of waste is not managed and disposed of in any place. Whereas daily waste increases, while available land remains, so the carrying capacity of the land decreases [31].

In addition to the application of appropriate technology, the availability of land for appropriate technology, then based on Table 3, it is easy to get the right technology for waste management as the third priority after the application of appropriate technology, availability of land for appropriate technology. The ease of application of technology is helped by the ease with which people access information about various knowledge to manage waste. Complete information includes the ease of application of technology and the place of technology providers to greatly help the community to manage waste further [32]..

Based on the selection of priorities on actors and criteria, according to the results of the SuperDecisions software, a key person (government, community and private) waste management strategy is selected as the first rank of the waste management strategy with a priority of 54.9806% followed by composting in second place and sanitary landfill as third place. Recycling is the best solution because it is low-cost when compared to expensive sanitary landfills, can be done at the household level [33], can reduce the spread of diseases from waste stacks [8], can improve the welfare of the community, can increase the value of waste [26], can reduce water pollution, can reduce land pollution [34], can reduce air pollution [35]. Waste recycling can also be a culture that must always be developed in the community. According to [9] in 2014, Indonesia's recycling population had only reached 1.23% and the population of Central Java had only reached 1.19%.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis, waste recycling is the best strategy chosen, with the main actor managing waste is the government. Waste recycling was chosen as a strategy for waste management in Central Java because of cost, easy to implement, simple technology, reducing environmental pollution, so that public health is created.

Increasing the role of all elements of society, namely the government, the private sector and the community itself and all aspects of waste management, such as management techniques, culture, politics, social, environmental, economic and institutional as well as optimal combinations of methods of prevention, reduction, recovery and disposal. So that integrated waste management can be carried out well.

REFERENCES

[1] Ludwig, Christian; Hellweg, Stefanie dan Stucki, Samuel. (2012). *Municipal solid waste management: strategies and technologies for sustainable solutions* . Berlin: Springer Science & Business Media.

[2] UNEP . (2018). Integrated Solid Waste Management . from http://web.unep.org/gpwm/.

[3] Passarini, Fabrizio; Vassura, Ivano; Monti, Francesco; Morselli, Luciano dan Villani, Barbara. (2011). Indicators of waste management efficiency related to different territorial conditions. *Waste Management, 31* (4), 785-792. doi: 10.1016/j.wasman.2010.11.021.

[4] Allesch, Astrid and Brunner, Paul H. (2014). Assessment methods for solid waste management: A literature review . *Waste Management & Research, 32 (6)* 461 -473 . doi: 10.1177 / 0734242X14535653.

[5] Kumar, Sunil . (2016). *Municipal Solid Waste Management in Developing Countries* . New York : CRC Press is an Imprint of Taylor & Francis Group.

[6] Reddy, P Jayarama. (2011). *Municipal solid waste management* . Florida: CRC Press (Taylor & Francis Group).

[7] Contreras, Francisco; Hanaki, Keisuke; Aramaki, Toshiya and Connors, Stephen. (2008). Application of analytical hierarchy process to analyze stakeholders preferences for municipal solid waste management plans, Boston, USA. *Resources, Conservation and Recycling, 52* (7), 979-991.

[8] Ejaz, N ; Akhtar, N dan Naeem, U Ali . (2010). Environmental Impacts of Improper Solid Waste Management in Developing Countries: A Case Study of Rawalpindi City . *The sustainable world, 142* , 379-388. doi: 10.2495/SW100351.

[9] Central Bureau of Statistics. (2015). *2014 Environmental Care Behavior Indicator* . Jakarta: Central Bureau of Statistics.

[10] Satker-PPLP-Central Java. (2015). *Profil Sanitasi Jawa Tengah* . Semarang : Satker-PPLP- Central Java.

[11] Ohri, Anurag; Maurya, Satya PRAKASH dan Mishra, Sachin. (2015, October 9-10, 2015). *Sanitary Landfill Site Selection by Using Geographic Information System.* Paper presented at the National Conference on Open Source GIS: Opportunities and Challenges, Varanasi, India.

[12] Saaty, Thomas L. (2004). Decision making — the Analytic Hierarchy and Network Processes (AHP/ANP). *Journal of Systems Science and Systems Engineering, 13* (1), 1-35. doi: 10.1007/s11518-006-0151-5.

[13] Saaty, Thomas L dan Vargas, Luis G. (2012). *Models, methods, concepts & applications of the analytic hierarchy process* (Vol. 175): Springer Science & Business Media.

[14] Batagarawa, Rabia; Williams, John Barry; Potts, Jonathan Stephenson and Brown, Julia Catherine. (2015). Use of analytic hierarchy process (AHP) as an instrument to develop a solid waste management assessment tool.*Global Journal of Advanced Engineering Technologies, 4* (2), 70.

[15] Ciocoiu, Carmen Nadia ; Colesca, Sofia Elena and Burcea, S. (2011). *An AHP approach to evaluating the implementation of WEEE management systems* . Paper presented at the Recent Researches in Environment, Energy Planning and Pollution - Proc. of the 5th WSEAS Int. Conf. on Renewable Energy Sources, RES.

[16] Shekdar, Ashok V. (2009). Sustainable solid waste management: an integrated approach for Asian countries. *Waste Management, 29* (4), 1438-1448.

[17] Callan, Scott J and Thomas, Janet M. (2013). *Environmental economics and management: Theory, policy, and applications* : Cengage Learning.

[18] Okello, Nick; Beevers, Lindsay; Douven, Wim dan Leentvaar, Jan. (2009). The doing and un-doing of public participation during environmental impact assessments in Kenya. *Impact assessment and project appraisal, 27* (3), 217-226.

[19] Guerrero, Lilliana Abarca; Maas, Ger dan Hogland, William. (2013). Solid waste management challenges for cities in developing countries. *Waste Management, 33* (1), 220-232.

DOI: 10.31695/IJASRE.2018.32853

[20] Niza, Samuel ; Santos, Eduardo ; Costa, Inês ; Ribeiro, Paulo dan Ferrão, Paulo . (2014). Extended producer responsibility policy in Portugal: a strategy towards improving waste management performance .*Journal of Cleaner Production, 64* , 277-287 . doi: 10.1016/j.jclepro.2013.07.037.

[21] Seadon, JK (2006). Integrated waste management – Looking beyond the solid waste horizon. *Waste Management, 26* (12), 1327-1336. doi: 10.1016/j.wasman.2006.04.009.

[22] Hazra, Tumpa dan Goel, Sudha. (2009). Solid waste management in Kolkata, India: Practices and challenges. *Waste Management, 29* (1), 470-478. doi: 10.1016/j.wasman.2008.01.023.

[23] Mishra, Rajesh; Mohammad, Naseer dan Roychoudhury, Nilanjan. (2016). *Soil pollution: Causes, effects and control* (Vol. 3).

[24] Regional Representative Council-Republic of Indonesia. (2017). Very Expensive, Waste Processing Technology is Difficult to Fulfill Regions. from DPD RI http://www.dpd.go.id. [Accessed: 10-May-2018].

[25] Parthan, Shantha R; Milke, Mark W; Wilson, David C dan Cocks, John H. (2012). Cost estimation for solid waste management in industrialising regions–Precedents, problems and prospects. *Waste Management, 32* (3), 584-594.

[26] Ghisellini, Patrizia; Cialani, Catia dan Ulgiati, Sergio. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production, 114* , 11-32.

[27] Grazhdani, Dorina. (2016). Assessing the variables affecting on the rate of solid waste generation and recycling: An empirical analysis in Prespa Park. *Waste Management, 48* , 3-13. doi: 10.1016/j.wasman.2015.09.028.

[28] Central Bureau of Statistics. (2016). *Development of Some of Indonesia's Main Socio-Economic Indicators* . Jakarta: Central Bureau of Statistics.

[29] Kinnaman, Thomas C . (2000). *The economics of residential solid waste management* : Routledge.

[30] Ion, Istudor dan Gheorghe, Filip Florin. (2014). The Innovator Role of Technologies in Waste Management towards the Sustainable Development. *Procedia Economics and Finance, 8* , 420-428. doi: 10.1016/S2212-5671(14)00109-9.

[31] Okumura, Shigefumi; Tasaki, Tomohiro dan Moriguchi, Yuichi. (2013). Economic growth and trends of municipal waste treatment options in Asian countries. *Journal of Material Cycles and Waste Management, 16* (2), 335-346.

[32] Haider, Jutta. (2016). The Shaping of Environmental Information in Social Media: Affordances and Technologies of Self-control. *Environmental Communication, 10* (4), 473-491. doi: 10.1080/17524032.2014.993416.

[33] Sukholthaman, Pitchayanin dan Sharp, Alice. (2016). A system dynamics model to evaluate effects of source separation of municipal solid waste management: A case of Bangkok, Thailand. *Waste Management, 52* , 50-61. doi:https://doi.org/10.1016/j.wasman.2016.03.026.

[34] United-Nations. (2016). Waste Management. Sweden: United Nations.

[35] Giovanis, Eleftherios. (2014). Relationship between Recycling Rate and Air Pollution: Evidence from Waste Management Municipality Survey in the State of Massachusetts. *Browser Download This Paper*.