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Household Hazardous Solid Waste (HHSW) Management Schemes in Sleman Regency for Future

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Abstract. Most people (85.52%) in Sleman regency treats the Household Hazardous Solid Waste (HHSW) improperly by open burning or dumping in rivers, yards or vacant lands. The presence of hazardous materials contained in the HHSW can lead to public health problems such as poisoning, accidents, illness, and even death. These study aims were to investigate the generation of HHSW and to choose the most optimal solutions to HHSW management in Sleman regency for the future. The generation of HHSW was obtained from the monthly sample survey of 120 households. Planning of HHSW management schemes was conducted by the back-casting approach while selecting the best alternative was made by Multi-Criteria Decision Analysis. Results of the study shown that HHSW generation average in Sleman regency was 2.438 g/person/day or about 2.81 tons/day in 2013. Electronics, electric bulbs and batteries were the dominant sources of HHSW in percentage, which contained 24.91%, 18.08%, and 16.71% respectively. The community-based HHSW management is the most optimal of three schemes to be applied in Sleman regency for future.

1. Introduction

The use of household items such as batteries, fluorescent lights, insecticides, lighters, paint and perfume sprays (aerosol), disinfectants, medicines, pharmaceuticals, and electronics will eventually become Household Hazardous Solid Waste (HHSW). HHSW is the residue of a business and/or activities that contain hazardous substances and/or toxic due to the nature and/or concentration and/or amount, either directly or indirectly, can pollute and/or damage the environment, and/or may endanger the environment, health, survival of humans and other organism (the Government regulation of Indonesian Republic number 101 of 2014). Domestic solid waste which has characteristics: explosive; flammable; reactive; toxic; infectious; and/or corrosive is HHSW. In US legislation, HHW is described as “*Leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients*” [1].

Most of the waste (85.52%) in Sleman regency including HHSW is not managed properly and is directly burned or dumped into rivers and yards, while 11.85 % is transported and disposed by the Government in landfill of Piyungan, and the remaining 2.63% is divided by the Community Based Solid Waste Management (CBSWM) Groups [2]. HHSW is not managed properly, therefore, have some negative impacts on the environment and humans.

Electronic waste including battery and fluorescent lamps is a type of HHSW that contains various harmful heavy metals such as Cd, Co, Cu, Fe, Pb, Li, Hg, Mn, Ni, Ag, Cr (VI), and organic contaminants such as BFRs, PAHs, PCBs, PBDD/Fs and PVC [3]. Incorrect disposal of electronic waste in the long term can lead to nervous system disorders, endocrine, reproductive, kidney, bone,



lung, skin, fetal.[3-5]. Used pesticide containers dumped in the environment can contaminate the groundwater, so it is very dangerous for the people who consume them. Burning packaging of aerosol products (perfumes, paints, insecticides, etc.) can cause explosions and endanger the people around them. Used syringes carelessly discarded can injure the health and even spread infectious diseases such as hepatitis B and HIV-AIDS on workers and scavengers[6]. Until now there is no HHSW handling system. It is necessary to plan some HHSW management schemes and choose the most optimal alternative to be applied in Sleman regency in the future. One of the important factors in the planning of HHSW management system is measuring the generation of waste produced by each household.

2. Methods

The generation is studied by collecting HHSW of 120 families in four CBSWM groups in Sleman regency consist of 1) Sukunan village, 2) Senuko village, 3) GandokKadilobo village and 4) Minomartani village. Samples were taken at simple random sampling technique by 30 households of each CBSWM group. Households are expected to be collected HHSW for 30 days.

Each household was given garbage bags labeled and coded to accommodate HHSW generated for 30 days from the receipt of those collecting bags. HHSW that has been collected from every household has identified the type, quantity, and weight.

Meanwhile, the best alternative of HHSW management in Sleman regency in the future was determined by the back-casting approach and Multi-Criteria Decision Analysis (MCDA) with Simple Additive Weighting Method (SAW) taking into account aspects of regulatory, institutional, operational technique, financing, community acceptance and health and environment impacts.

3. Result

3.1. HHSW Generation

The quantity of HHSW in Indonesia is still relatively small, which is about 2% of the total type of household waste[6a]. The HHSW generation in Padang City is on average 0.041 l/person/day or 0.004 kg/person/day,[7] while in Jambangan sub-regency, Surabaya is 1.6 g/person/day).[8] The generation of HHSW in Mexico City is 1.6% of all waste in the city,[7a]the United States is around 1.6 million tons, [7b] and Japan amounts to 2 kg/person/year or about 5.56 grams/person/day and Denmark is about 5 kg/person/year or about 13.89 grams /person/day [9].

The research collected 33 types and 568 items of the Household Hazardous Solid Waste (HHSW) that produced by 120 households and 486 persons during 30 days. The HHSWs could be categorized into 9 groups. Amount and weight of items are presented in Table 1.

Table 1. Household Hazardous Solid Waste (HHSW) Generation

No	Categories	Amount (items)	Weight (g)
1	Battery	122	5938
2	Lighting lamp	140	6425
3	Electronic	62	8854
4	Paint containers	22	2278
5	Pesticide containers/packaging	22	2169
6	Medicine & Pharmacy	66	2415
7	Oil and gas containers	39	1882
8	Personal care and beauty products	65	3894
9	Home care products	30	1689

Total of HHSW	568	35544
Average of HHSW Generation	0.039/item/day	2.44 gram/person/day

Table 1 shows that the average of HHSW generation in Sleman regency is lower than Padang City, Japan, and Denmark, but higher than Jambangan sub-regency, Surabaya. HHSW generation estimation in Sleman regency in 2013 was as much as 1,151,646 inhabitants x 2.44 grams/person/day = 2,807,712.95 grams/day or 2.81 tons/day. By weight, the three dominant types of HHSW are identified as electronic waste, electric bulbs, and batteries.

3.2. HHSW Management Plan Schemes in Regency

There are three schemes of HHSW management plan are arranged. Those schemes are:

3.2.1. Community-based HHSW management system (alternative-1)

The community-based HHSW system puts the community as the main responsible for HHSW management from reduction and recovery activities through the emptying, cleaning and collection components of salable until final settlement.

3.2.2. Producer-based HHSW management system (alternative-2)

The producer-based HHSW management system puts the producer (manufacturers) as the main responsible in the management of HHSW through Extended Producer Responsibility (EPR) program by take-back system the former packaging and leftover household products.

3.2.3. Government-based HHSW management system (alternative-3)

The government-based HHSW management system puts the local government as the main responsible for HHSW waste management service in the Regency.

3.3. Choosing the Most Optimal of HHSW Management

Until now there is no HHSW handling system in Sleman Regency. For choosing the most optimal alternative of HHSW management system in Sleman regency for future is needed a feasibility study to several aspects such as regulatory/laws, institutional, operational techniques, financing, community acceptance, as well as the health and environmental risks. The Multiple Criteria Decision Analysis (MCDA) with Simple Additive weighting method (SAW) was used for choosing the best alternative. MCDA is a method of decision making to establish the best alternative from a number of schemes based on several criteria/certain aspects[10].

The selection of the best alternative use methods of MCDA through the stages: 1) formulating objectives, 2) develop schemes, 3) determine the criteria, 4) build a hierarchical structure issues, 5) determine and assess the weights of criteria and the degree of suitable any alternative criteria, 6) perform aggregation weights of criteria and the degree of suitable of any alternative criteria, 7) set priorities or rank of alternative decisions based on the results of aggregation, and 8) choose an alternative decision with the highest priority as the optimal alternative[10].

3.4. Determine The Criteria and Weighting Criteria

There are five criterions for consideration in selecting the most optimal alternative for HHSW management in Sleman regency: 1) compliance with applicable regulations; 2) the availability of the institution; 3) the technical implementation; 4) finance; 5) public acceptance; and 6) the health and environmental impacts. Weight (w) of each criterion is determined by the level of interest, namely: very low (weight 1); low (weight 2); enough (weight 3); height (weight 4); and very high (weight 5). Preference weights in this study were obtained from three assessors include 1) head of Indonesia Solid Waste Association (INSWA); 2) expert of hazardous and toxic waste management from the Institute of Technology Bandung (ITB); and 3) head of the Yogyakarta community-based solid waste

management association. Average preference weight of the three assessors is: rules/laws (C.1) = 5 (very high); institutional (C.2) = 4 (high); technical and operational (C.3) = 4 (high); finance (C.4) = 4 (high); community acceptance (C.5) = 4 (high); environmental and health risk (C.6) = 4 (high).

3.5. Develop A Decision Matrix And Determine The Suitability Rating of Each Alternative on Each Criterion

The first step is to create a table rating the suitability of each alternative on each criterion with the results as the Table 2.

Table 2. Rating suitability of each alternative on each criterion

Schemes	Criterion					
	C-1	C-2	C-3	C-4	C-5	C-6
A.1	3	4	4	4	4	3
A.2	4	2	2	4	3	4
A.3	4	3	4	2	4	3

Based on table 2, the decision matrix is formed as follows:

$$X = \begin{bmatrix} 3 & 4 & 4 & 4 & 4 & 3 \\ 4 & 2 & 2 & 4 & 3 & 4 \\ 4 & 3 & 4 & 2 & 4 & 3 \end{bmatrix} \quad (1)$$

Furthermore, normalized matrix is made with the following results :

$$R = \begin{bmatrix} 0.75 & 1.00 & 1.00 & 1.00 & 1.00 & 0.75 \\ 1.00 & 0.50 & 0.50 & 1.00 & 0.75 & 1.00 \\ 1.00 & 0.75 & 1.00 & 0.50 & 1.00 & 0.75 \end{bmatrix} \quad (2)$$

The ranking process is obtained by the equation:

$$V_i = \sum_{j=1}^n w_j r_{ij} \quad (3)$$

Results of each alternative are as follows:

$$V_1 = 5(0.75) + 4(1.00) + 4(1.00) + 4(1.00) + 4(1.00) + 4(0.75) = 22.75 \quad (4)$$

$$V_2 = 5(1.00) + 4(0.50) + 4(0.50) + 4(1.00) + 4(0.75) + 4(1.00) = 20.00 \quad (5)$$

$$V_3 = 5(1.00) + 4(0.75) + 4(1.00) + 4(0.50) + 4(1.00) + 4(0.75) = 21.00 \quad (6)$$

Based on the calculation above that V_1 is the highest value, followed by V_3 and V_2 , so that the community-based HHSW management (alternative-1) is the most optimal scheme to be applied in Sleman regency for future.

3.6. Reviewing of The Regulatory/Law Aspect

Indonesia has had regulations on the management of hazardous waste and toxic namely government regulation number 101 of 2014. The regulations prohibit the producers of hazardous waste including household directly from dumping the waste into the environment without prior treatment. Regulation is absolutely necessary as the legal basis and guidelines for the community in the running of HHSW management, but there are no specific regulations governing the mechanism of HHSW until now.

Based on the fact, it is all schemes still require Sleman regency regulation, especially on HHSW management and its implementation instructions. For the alternative-1, it is still needed additional provisions regulating the ways discharge and cleaning the hazardous household product packaging. This instruction is very important to prevent injury and harm to the community when sorting the valuable HHSW. While the alternative-2 already has regulations both national and provincial which require manufacturers to run the EPR program to conduct taken back residual products and used packaging. The alternative-3 has a rule that the local government should be responsible for the implementation of waste management in the region.

3.7. *Reviewing of Institutional Aspects*

Reviewing from the institutional aspects, alternative-1 has an advantage because there are many CBSWM groups that established in Sleman regency. They have collected many salable wastes including some types of HHSW and sold to a garbage buyer (middleman), and then sent to recycling factories. All middlemen in Sleman regency don't have a license from the government to the collection and store the hazardous waste. They are just like home industries, so it's very necessary to improve the status of the middleman into a business entity (legal industry) for collecting and utilizing some types of HHSW.

Institutions are required to alternative-2 is the producer organization for managing and implementation of the EPR program, which until now there is no manufacturer to take back the packaging and the expired and unused hazardous products in Sleman regency, and even producers tend to oppose the implementation of EPR policy in Indonesia.

Meanwhile, a technical service unit or a Government-owned enterprise is required to conduct the alternative-3 for managing all HHSW in Sleman regency. Therefore the terms of the institutional aspects of the most viable schemes were prioritized following the order as alternative-1; alternative-3; alternative-2.

3.8. *Reviewing of Operational Technique Aspects*

The first step in managing HHSW is separation at source. Sorting at source by separating the HHSW in the household is the best way to prevent the major part of the waste from being contaminated and thus open up for an easier and less costly handling. Segregation model among those schemes is different. Separating HHSW mechanism of the alternative-1 is based on valuable and worthless components. Separating HHSW mechanism of alternative-2 is according to EPR and not-EPR, while that of alternative-3 is depended on household hazardous waste (HHW) and not-HHW.

For implementation, the HHSW management requires the roles of various parties (stakeholders). Alternative 1: CBSWM groups in Sleman regency generally already have infrastructure such as a sorting and storage bins, including has been working with various stakeholders, so the alternative-1 has the highest weight compared to alternative-2 and alternative-3. Alternative-2 is more difficult to implement than the alternative-3 because there are no producers who take back their former products. Alternative-3 is more likely to be implemented than the alternative-2 because so far the Sleman regency has organized waste services, so it only needs to increase the scope of services that handle HHSW. Thus, in terms of technical operations, the feasibility from the highest to lowest is alternative-1; alternative-3; and alternative-2.

3.9. *Reviewing of Financing Aspects*

HHSW management needs operational cost for both transportation and managing. One of the hazardous waste management service companies in the Yogyakarta area is PT. PPLI (a private sector). Management cost depends on the type and quantity of HHSW. The cost of management for all types of hazardous waste, calculated using the unit volume of 200 liters or 44 gallons (drum), except for electronic waste using the unit of weight (per kilogram). By the conversion of units of weight into a volume according to the density of each type of HHSW obtained that estimated management costs of HHSW in Sleman regency, shown in Table 3.

Table 3. Management cost estimation of HHSW in Sleman Regency through PT. PPLI

HHSW Category	Amount of HHSW	Cost unit	Managing cost (IDR/month)	Transporting cost (IDR/month)	Total cost (IDR/month)
	7367.33 L	IDR 900,000/200 L	33,152,979.05	6,906,870.63	40,059,849.68
Lighting bulbs	73624.30 L	IDR 950,000/200 L	349,715,427.45	69,022,781.73	418,738,209.18
Medicine	21676.84 L	IDR 650,000/200 L	97,545,773.36	20,322,036.12	117,867,809.48
Pesticide	45481.27 L	IDR 1,500,000/200 L	341,109,536.15	42,638,692.02	383,748,228.17
Packaging	103939.80 L	IDR 600,000/ 200 L	311,819,401.10	97,443,562.85	409,262,963.95
Paint	6503.67 L	IDR 900,000/200 L	29,266,505.89	6,097,188.73	35,363,694.62
Electronic waste	20,98 ton	IDR 2,500,000/ton	52,452,025.12	18,324,150.31	70,776,175.43
			1,215,061,648.12	260,755,282.38	1,475,816,930.5

The total cost of HHSW management in Sleman regency 2013 through PT. PPLI service without reduction, recovery or taking back is IDR 1,475,816,930.50 per month. The amount of management cost depends on how much HHSW can be reduced. A reduction in the amount of hazardous waste varies from one to the other schemes depending on the form of the activities undertaken. Reduction of HHSW in the alternative-1 was conducted by the recovery and sale of some safe components of HHSW that can be recycled while reducing the amount of HHSW for alternative-2 is calculated based on the amount of HHSW can be returned to the producer. All amount of the HHSW in alternative-3 is managed by the local government.

The greatest alternative in reducing management costs is an alternative-2 is Rp.1,031,190,271.94/month followed by alternative-1 is IDR 149,749,737.37/month and there is no reduction in costs for alternative-3. Alternative-1 has advantages compared to other schemes, because of the selling some components of HHSW, the community will make a profit of IDR 75,968,352.09/month, because of the selling some components of HHSW. The economic benefits for the community of the alternative-2 can't be calculated because there are no producers are willing to run the EPR in Sleman regency. Meanwhile the alternative-3, there is no economic benefits and even the community should pay all the cost of HHSW management. Financing lowest of HHSW management is the alternative-2 (IDR 444,626,658.56/month) and the highest is the alternative-3 (IDR 1,475,816,930.50/month). Meanwhile financing of the alternative-1 is IDR 1,250,098,841.04/ month.

3.10. Reviewing of Community Acceptance Aspect

Study of the aspects of community acceptance is done by giving the question attitudes to 120 households and 30 managers in four groups CBSWM. Each of the respondents chooses one option: strongly agree; agree; undecided; disagree; or strongly disagree. When they choose strongly agree and agree to a question then categorized as "accept". If they choose to disagree and strongly disagree option then categorized as "rejected".

Results of the study of community acceptance aspects of each alternative show that the percentage of respondents who accepted largest of which are: alternative-1 (48.96%); alternative-3 (46.98%); and alternative-2 (41.04%). The highest rejection percentage of the alternative-1 is related to the recovery of activities that must be undertaken by households (29.83%). Reviewing from the percentage difference between acceptance and rejection, the highest alternative of HHSW management is alternative-1 (+ 19.21%), alternative-3 (+ 18.54%) and alternative-2 (+ 14.27%). Thus the order of feasibility in terms of social aspects from the highest are alternative-1; alternative-3; and alternative-2.

3.11. Reviewing of Environmental and Health Risk Aspect

Study aspects of health and environmental risks were carried out against the handling process and the amount of hazardous waste that can be reduced so as not discharged directly into the environment. Each alternative is assessed the potential risks arising from every HHSW handling activities. Besides, it is also calculated the amount of HHSW that can be reduced to estimate the risk reduction of environmental pollution and public health problems [11].

When viewed from the potential negative impacts on the environment and public health, the alternative-1 has the highest risk, while alternative-2 and alternative-3 have a relatively similar risk. However, if viewed from a potential reduction in the quantity of HHSW (positive impact), the alternative-1 has the highest percentage (94.51%), followed by alternative-2 (73.01%) and alternative-3 (60.00%). Thus, if taking into account the potential impact (negative and positive; process and output), the alternative-2 and alternative-3 have a potential impact of relatively similar and are better than the alternative-1.

4. Discussion

In accordance to Act of Indonesia Republic, No.18 of 2008 concerning the waste management; Act No. 32 of 2009 on the protection and management of the environment; and the Indonesian Government Regulation No. 101 of 2014 states that every person who generates waste must be responsible for managing. As the producer of HHSW, the community in groups can manage more efficiently.

In the USA, the impetus for starting a HHW program came from the community groups. Early single-day household hazardous waste (HHW) collection sprang up at the local level. HHW collection activities were first carried out in Lebanon, Marion County, Kentucky, the USA in 1981 and managed to collect nineteen hundred pounds of pesticides. Furthermore, many communities have established the HHW collection program (single-day or short-duration collection events). The number of HHW collection program in all 50 states of USA until 1991 is more than 3,000. Currently, USA began to develop a permanent program to collect HHW at least once per month. People can store HHW in the permanent facility that has become more common provides greater convenience to residents by offering more collection opportunities. Many HHW collections provide a reuse (drop and swap) option for less hazardous leftover that is still useable and safety. This method can reduce costs by eliminating disposal[12].

Based on that, the HHSW collection in Sleman can be done through groups formed by the community. Until 2013, there were 91 groups of the community who have been running community-based waste management systems[2]. Community groups are generally willing to run the waste management because of the economic benefits. Waste management with the principle of "trash to treasure" is very effective for building community participation to sort and recycle waste [13, 14]. Community-based HHSW management (alternative-1) is the best alternative to be applied in Sleman regency in the future, because of the community will benefit directly from the sale of some types of HHSW that can be recycled by the company. Unfortunately, until now the community groups and the informal waste recycling sector in carrying out its activities, not in accordance with the standards of health and safety. Thus they still need to be improved in the future. Through local regulations no. 04 of 2015, the Government of Sleman regency encourages community-based waste management by establishing a waste management group in each village.

While producer-based waste management (alternative-2) actually also be profitable for the community, because it will reduce the amount of waste sent to the services and costs. But implementation of Extended Producer Responsibility (EPR) program through an HHSW returns system from the community to producers in Indonesia face several obstacles. Some issues to the implementation of EPR in developing countries in Asia were: 1) many products don't have brand that causes difficulty to identify the producer; original components often get replaced with those of other brands or generic parts; some products are smuggled into the country, and producers frequently go out of business; 2) competition with the informal waste management sector. The informal waste recycling sector has low operating costs (compared to formal recycling businesses that meet governmental standards of occupational safety and environmental protection) and it can, therefore, offer households relatively higher cash payments; 3) Poor infrastructure for HHSW collection and treatment; 4) Community awareness of potential hazards is low. People prefer to consider HHSW as a valuable commodity than hazardous waste. Therefore they generally expect collectors to pay for their

HHSW[15]. EPR is an environmental policy approach that attributes responsibility to manufacturers in taking back products after use and is based on polluter-pays principles [16, 17]. In the USA, many retail electronics stores accept rechargeable batteries and some retail chains are beginning to experiment with take-back of computers, monitors, and other consumer electronics (e-waste) [12].

It is difficult to conduct the take-back program in Indonesia. Indonesia has thousands of islands scattered widely, and it's costly to take back the postconsumer products by producers. The transportation cost for collecting the HHSW is very high. Therefore the Indonesian businessmen reject to run the EPR program. The willingness of manufacturers is the key to the implementation of EPR programs. So alternative - 2 is still very difficult to run in Sleman. Some types of HHSW that allow being taken back by the manufacturers are batteries, electric lights, pesticide packaging, electronic waste, and expired medicine.

The HHSW based on local government (alternative-3) in accordance with the Constitution Act of the Republic of Indonesia no. 18 of 2008 which stated that the government should be responsible for the implementation of waste management in the region. In this system, people just separate and collect the HHSW at the source and then handed over to the Government through community groups. But community must bear the cost of managing HHSW to the Government. Furthermore, the Government may delegate to a service provider that organizes the management of HHSW waste and community must bear the cost of management.

5. Conclusion

The average of HHSW generation in Sleman regency was 2.44 g/person/day or approximately 2.81 tons/ day in 2013, where electronic waste (24.91%), electric bulbs (18.08%) and battery (16.71%) are the three major types of HHSW. The community-based HHSW management (alternative-1) is the most optimal scheme of three alternatives to be applied in Sleman regency for future.

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Reference

- [1] USEPA 2005 Municipal Solid Waste, Household Hazardous Waste, Office of Solid Waste, Washington DC: United States Environmental Protection Agency.
- [2] IswantoSudarmadjiWahyuni E T and Sutomo A H 2016 TimbulanSampah B3 Rumah tanggadanPotensiDampakKesehatan di KabupatenSleman, *J. ManusiadanLingkungan*, **23(2)**; 179-188.
- [3] Kidee P Naidu R and Wong M H 2013 Electronic Waste Management Approaches: an Overview, Elsevier *J: Waste Management***33**: 1237-1250.
- [4] Kumar S N and Jain A K 2014*E-Waste: Health Impacts in Developing Countries, The Environmental Toxicology*(New Delhi: ICMR and the Safdarjang Hospital Campus).
- [5] Puckett J and Smith T 2002 *Exporting Harm the High-Tech Trashing of Asia, in Coalition*, S.V.T. (Ed.).
- [6] Conn W D 1989*Managing Household Hazardous Waste* (USA: American Planning Association, Spring).
- [6a] Damanhuri E and Padi T 2010*PengelolaanSampah* (Bandung: Program StudiTeknikLingkungan FTSL, ITB).
- [7] Ruslinda Y and Yustisia D 2013AnalisisTimbulandanKomposisiSampahBahanBerbahaya Dan Beracun (B3) RumahTangga di Kota PadangBerdasarkan Tingkat Pendapatan*J :LingkunganTropis*, **7(1)**: 21-30.
- [7a] Otoniel B D Liliana M B and Francelia P G 2008*Consumptionpatterns and householdhazardoussolidwastegeneration in anurbansettlement in*

- México, Michoacan Mexico: Instituto De Investigaciones Agrícolas y Forestales, Universidad Michoacana De San Nicolás De Hidalgo, Av. San Juanito Itzicuaró S/N, Col. San Juanito Itzicuaró, C.P. 58330, Morelia-Aeropuerto.
- [7b] USEPA 2000 *Best Management Practices Resource Guide, Chapter 1 : Household Hazardous Waste*, (Georgia: Region 4 DoD Pollution Prevention Partnership).
- [8] Mustikawati Y D P and Trihadiningrum, Y 2009 *Studi Pengelolaan Sampah B3 Permukiman di Kec. Jambangan Surabaya* (Surabaya: Jurusan Teknik Lingkungan FTSP ITS).
- [9] Benitez S O Virgen Q A Gonzales P T and Sotelo S E C 2013 Household Hazardous Wastes as a Potential Source of Pollution: a Generation Study. *Waste Management & Research* **31(12)**:1279-1284.
- [10] Kusumadewi SHartati, S Harjoko A dan Wardoyo 2006 *Fuzzy Multi-Attribute Decision Making (Fuzzy MADM)*, (Yogyakarta: Graha Ilmu).
- [11] Galvin D and Dickey P 2008 What Is Household Hazardous Waste, *Handbook on Household Hazardous Waste*, edited By Amy D (Cabaniss, USA: Government Institutes).
- [12] Galvin D 2008 The History and Current Status of Household Hazardous Waste Management, *Handbook on Household Hazardous Waste*, edited By Amy D. (Cabaniss, USA: Government Institutes).
- [13] Mongkolnchaiarunya J 2005 *Promoting a Community-Based Solid-Waste Management Initiative in Local Government*, Yala Municipality, Thailand, *Habitat International* **29** (2005): 27–40.
- [14] Iswanto 2012 Community Initiative In Sukunan Village Sleman, Indonesia : a Journey from Waste to the Eco-Tourism Village, *J. of Community Health*, **18(1)**: 13-17.
- [15] Akenji L Hotta Y Bengtsson, M and Hayashi S 2011, *EPR Policies for Electronics in Developing Asia: A Phase-in Approach*, Japan: Institute for Global Environmental Strategies 2108-11 Kamiyamaguchi, Hayama, Kanagawa Policy Brief No. **14**, September 2011.
- [16] OECD 2001 *Extended Producer Responsibility: A Guidance Manual for Governments* (OECD Paris, France).
- [17] Widmer R Oswald-Krapf, H Sinha-Khetriwal D Schnellmann M Boni H 2005 Global Perspectives on e-Waste. *Environmental Impact Assessment Review* **25**: 436-458.