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Preliminary Assessment of Economic Feasibility for Establishing a Households' E-waste PC Dismantling and Sorting Facility in Serang, Indonesia

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Abstract. Electronic and electrical equipments (e-waste) generated in Indonesia is expected to increase due to high growth of economy and fast development in technology. As Indonesia has not yet had specified criteria on e-waste, in this study, e-waste is defined as any obsolete or unwanted electronic and electrical equipment which are introduced into recycling and disposal process. The objective of this study is to assess the financial feasibility of an e-waste recycling business for dismantling and sorting end-of-life personal computers (PC) generated from households in Indonesia. The method that was used in this study is benefit cost analysis which applied on a monthly basis in 2015 under a certain condition and assumptions. The results showed that this business is feasible unless there is any change in metal prices because the only revenue source was intrinsic value of metal contained in the e - waste PC. Therefore, additional revenue should be established in order to ensure sustainability of this activity.

Keywords: E-waste, Household, PC, Economic assessment, Dismantling and sorting

1. Introduction

The increasing of electronics and electrical appliances or equipments (EEE, or from here after referred to as, e-products) use has lead to generate waste of e-products (WEEE or e-waste) rapidly. High technology has been advancing and creating new product models which accelerate obsolescence and result in electronic appliances being discarded before the end of their useful life. However, if improperly managed throughout its life cycle, e-waste can cause environmental problems due to the content of potentially hazardous waste such as heavy metals, halogenated substances, PCBs, et cetera (BCRC, 2007). This matter became the subject at the Conference of Parties to the Basel Convention COP 6. It was agreed that e-waste considered a priority waste stream and environmentally sound management should continue to be given a high priority under the work program of the Basel Convention. It was also recognized that there is a lack of reliable data on the generation, collection, import and exports, and management schemes in general as well as implementation problems (BCRC, 2007). Except, the only data recorded was from Japan Environmental Sanitation Center, et al (2007), which Indonesia has imported 6,643 secondhand personal computer monitors.

Currently, there are no specific regulations regarding e-waste in Indonesia. From the previous study conducted by the Ministry of Environment (2010), it was recognized that importation of e-waste are existed by using other common terms such as mix metals scrap or plastic waste for recycling in their documents (Agustina, 2010). In Indonesia, generally it is difficult to find any e-waste dumped in official final disposals or landfills (Widyarsana, 2011). However, informal sector has played a major role in treating e-waste from household in Indonesia. They make a living by picking up any possible valuable waste from domestic waste stream and treat e-waste while exposing themselves to health hazards due to lacking of safety and environmental concern.

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It is necessary to know the possibility of establishing a formal scheme for e-waste management, particularly from the household. This formal scheme should not neglect the role of the existing informal sector in Indonesia and preserve their ability to collect e-waste efficiently. A rough estimation for assessing economic feasibility to establish an e-waste management system will be explained in this paper. Quantities of e-waste generation are based on the Andarani and Goto's study in 2012. The appliance chosen for this study is personal computer. Therefore, the objective of this study is to assess the financial feasibility of an e-waste recycling business for dismantling and sorting end-of-life personal computers (PC) generated from households in Indonesia.

2. Methods

2.1. Model Description

To assess the economic feasibility of establishing a recycling of household e-waste, a model is used to simplify the calculation. The model which is being used in this study is based on the model developed by Blaser and Schluep (2011) in Morocco, excluding refurbishment process. Basically, each step right after the e-waste discarded by users was analyzed and the cost would be determined to operate such operation. The scheme of this model can be seen in Fig. 1.

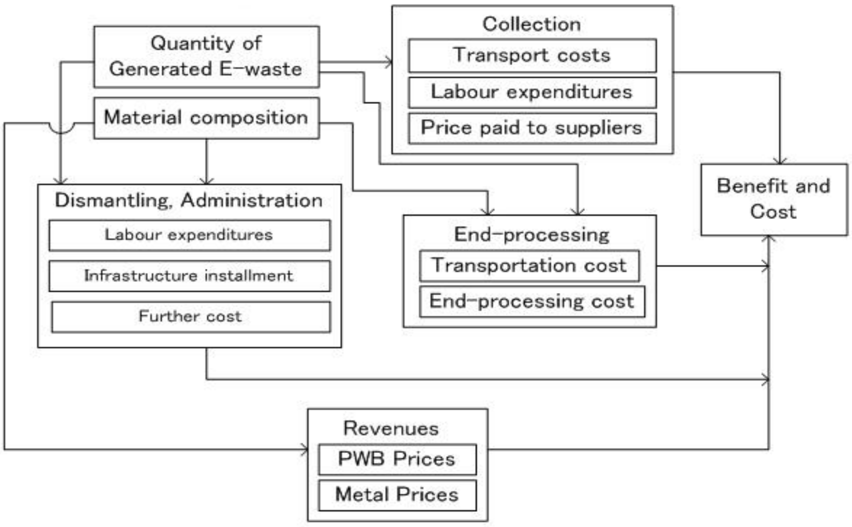

Fig. 1: Simple scheme of the Ms Excel model for the economic feasibility of e-waste dismantling and sorting facility (modified from Blaser and Schluep, 2011)

2.2. Data Collection

2.2.1. E-waste Flows

One of the important data for this model is the amount of e-waste which generated from households as this model only represents the e-waste management for households. This data is obtained from Andarani and Goto study in 2012, which presented in Table 1. The data is according to the baseline scenario in 2015 for personal computer.

Table 1. The estimation of generated e-waste from household in Indonesia (in tonnes)

Year\Type	Desktop PC	Portable PC	Total
2015	24,816	7,845	138,985

2.2.2. Cost Analysis

Any expenses involved in the e-waste PC dismantling and sorting facility, that is considered in the model will be explained as follows.

2.2.2.1. Labor Costs

It is common that an intensive labor is applied in Indonesia, as a developing country where the minimum wage is generally low. In Indonesia, the nominal wage per month of workers below supervisory level in the industry is 1,481,100 IDR per month (for West Java, Jakarta, and Banten region on other sector) in 2009 quarter IV (BPS, 2010). Based on experiences of other similar project in other countries, the wage of a common worker in a model facility (dismantling, refurbishing, etc.) is assumed to be 1,777,320 IDR ~ 1,780,000 per month, about 20% higher than the minimum wage. Other wages per month are determined as: secretary 4,000,000 IDR; driver 2,000,000 IDR ; manager 15,000,000 IDR (Kelly Services, 2011)[1].

2.2.2.2. Rental Costs

Because the actual location of dismantling facility is still unknown, it is difficult to determine the rental cost or land value for the facility infrastructure. The land value among locations in Indonesia is different each other. However, at this point, it is assumed that Serang, Banten Province (in an industrial area), has been chosen to build dismantling and sorting facility. For an industrial area in Serang, the selling price was about 350,000 IDR/m2 in average.(Toko Bagus property[2]). Investment to purchase land and building are paid monthly by installment for 10 years.

2.2.2.3. Commodity Prices

The commodity prices which were used in the model are the metals' price at May 15th , 2012 based on the LME (London Metal Exchange)[3] minus the following percentage price reductions:

- Copper LME – price minus 20% (Blaser and Schluep, 2011)
- Aluminum LME – price minus 20% (Blaser and Schluep, 2011)
- Scrap iron LME – price minus 50% (Blaser and Schluep, 2011)

The exchange rate from 1 USD was 9,213 IDR (based on Mandiri Bank4, May 15th , 2012). Table 2 shows the commodity prices which would be used in the model.

Table 2 Commodity Prices to be used in the model

Au (IDR/oz)	Ag (IDR/oz)	Pd (IDR/oz)	Cu (IDR/oz)	Al (IDR/oz)	Fe (IDR/oz)
14,232,000	255,000	5,712,000	57,887,000	13,897,000	2,045,000

Precious metals such as gold (Au), silver (Ag), and palladium (Pd) have a large share of the revenue. These metals could be recovered from Printed Wiring Boards (PWB) depend on their grade on the Au content. The following prices are based on Umicore[5] precious metals business unit in 2010 then its ratio was adjusted to current price of precious metals (May 15, 2012), after that, converted into IDR:

- PWB high grade (Au content of 200 - 300 ppm) 148,358,000 IDR/MT
  minimum lot size of 5 tonnes
- PWB medium grade (Au content of 100 - 200 ppm) 105,976,000 IDR/MT
  minimum lot size of 7 tonnes
- PWB low grade (Au content of 50 - 100 ppm) 39,379,000 IDR/MT
  minimum lot size of 10 tonnes

2.2.2.4. Transportation Costs

Table 3: Transportation costs for 6-m container (per month)

Direction	USD	IDR	source
Wakatobi → Serang	893.04	8,228,000	globalshippingcosts.com
Batam → Serang	449.68	4,143,000	globalshippingcosts.com
Jakarta → Serang	60.00	553,000	globalshippingcosts.com
Bandung → Serang	60.00	553,000	globalshippingcosts.com
Total	1,462.72	13,477,000	

Transportation plays a crucial role in e-waste management system. They provide end-of-life equipment movements from one place to another; hence, there are many kinds of transportation that are involved in the system, particularly for transporting between the existing regional collection centers, such as Wakatobi island (to manage eastern part of Indonesia), Batam island (western part), Jakarta (Java island), and Bandung (Java island). The cost for transportation refers to Table 3.

[1] Kelly Services Indonesia, Employment Outlook and Salary Guide 2011/12 (http://www.kellyservices.co.id/)
[2] Toko bagus property, http://properti.tokobagus.com/pabrik-dan-industri/ (in Indonesian language)
[3] London Metal Exchange, LME, http://www.lme.com/
[4]Mandiri Bank, http://www.bankmandiri.co.id/resource/kurs.asp
[5] Umicore precious metal business unit, http://www.preciousmetals.umicore.com/PMR/, cited from Blaser and Schluep, 2011

2.2.2.5. End-processing Costs

End-processing is a process to treat e-waste component that has been sorted and dismantled. The end-processing could bring a large share of expenditures depending on the amount of generated e-waste. For details, the end-processing cost can be seen in Table 4.

Table 4 End-processing costs for different fractions

fraction	costs (IDR/MT)
Complete cathode ray tube (CRT), undestroyed	774,000
CCFL (Hg-lamps from flat screens)	10,991,000
plastic, with and without flame retardants	774,000

(source: Blaser and Schluep, 2012)

2.2.3. Assumptions

Due to lack of reliable data, some assumptions have to be made, hence the results of the recycling modeling should be interpreted carefully.

Facility location	Serang, Banten
Appliances scope	PCs (desktop PC and portable PC)
Appliance composition	see table 5
Further costs	20% of total considered costs for total wages, including public relation and monitoring costs
Collection scheme	100% collected via informal sector (households)
Price paid to suppliers	CRT 65,000 IDR/unit; LCD 75,000 IDR/unit; others 1,212 IDR/kg
Commodity prices	see table 2
Recovery	75% of potential value is recovered by dismantling
Minimal wage	1,780,000 IDR per month per worker
Appliances for recycling	100%
Worker's productivity	- Sorting: 200 units/month per worker - Dismantling: 2.5 tonnes of e-waste per month per workforce (based on experiences from Cape Town, South Africa).
Revenue factor	100%
Work space/worker	50 m^2

Table 5: Material composition

Fraction	**PC**	**CRT monitor**	**LCD monitor**	**Portable PC**
Copper	0.03%	7.00%	0.65%	1.50%
Aluminum	4.92%	2.00%	3.10%	3.70%
Iron	75.06%	10.00%	35.25%	29.80%
Brass	0.02%			
PWB high grade			8.50%	
PWB medium grade	8.57%			6.50%
PWB low grade	1.31%	8.00%		
CRT glass		60.00%		
Plastics	5.80%	13.00%	18.50%	14.50%
Cables	2.75%		2.50%	1.00%
Residue (=waste)	1.54%	0.00%	31.50%	43.00%

Source: Blaser and Schluep, 2011

3. Results and Discussion

In this study, a cost benefit analysis for e-waste dismantling and sorting facility (DSF) business has been assessed. The appliances scope is PC because it contains a considerable amount of valuable materials, particularly gold. The treated e-waste volume was about 138,985 tonnes per year, comprises of desktop PC and portable PC (laptop, netbook, etc., excluding tablet PC). The cost benefit analysis was carried out based on a monthly basis. Under the given conditions, the business had reached revenue 22,850,589,630 IDR or 2,480,255 USD per month. Refurbishment process has been neglected in this analysis, however refurbishment could also bring revenue for the business. Total expenses for this activity were about 16,857,656,545 IDR or 1,829,768 USD, so the gained benefit was 5,992,932,085 IDR or 650,486 USD per month. It is important to note that revenue is depending on the metal prices, so that this business relatively has risks if the metal prices dropped suddenly. The revenue share of this business can be seen in Fig. 2. PWB has a major share (about 65%) of revenue. In Indonesia, existing recycling activities for household e-waste are recovering copper (from burned cables) and gold. Nevertheless, currently their recovery activities are still ignoring safety, health, and environment concern. Therefore, beside integrating the informal sector to collection scheme of household e-waste, they should also play a role in a proper recycling business (employment to the facilities).

In conclusion, the e-waste PC recycling business in Indonesia is feasible based on this preliminary cost and benefit analysis, but it is necessary to ensure the sustainability of this business, other financial support to provide additional revenue has to be established. Financing scheme to support e-waste recycling has been implemented in developed countries such as fee for disposal, advanced recycling fee, deposit – refund, general taxes, and fee on import (Blaser and Schluep, 2011). First of all, government should enact a specific regulation regarding e-waste management to protect the business. An effective collection scheme should be encouraged, across regional, between islands, should be coordinated properly. Then, the optimal location of DSF should be decided to minimize operation cost while maximizing the volume of e-waste that could be recovered.

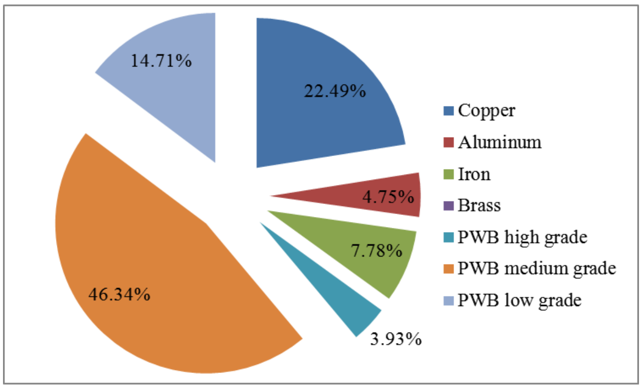

Fig. 2 : Revenue share

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