E-waste Generation in Developing Countries: Current Issues and Challenges

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Abstract

The rapid growth of in information and telecommunication technology ((ICT) has led to the improvement in the capacity of computers but simultaneously decrease the product lifetime which contribute to rapid amount of e-waste. This paper reviews about electric and electronic waste (e-waste) challenges faced by developing countries. There were several challenges such as awareness of citizen, existing of informal sector, financing problem as well as regulation of developing countries itself. Informal sectors are most active in waste recycling in developing countries because the profits made from the resale of recovered materials. They do not have an issue how to deal with the environment as long as they got the valuable and precious material from e-waste. Moreover, a lack of financial program forms a major drawback as e-waste treatment requires costly and advanced technology. Current e-waste generation keeps increasing in developing countries such as India, China, and Malaysia. The recovery facilities have increased tremendously as a result from the generation itself. Therefore, social approaches and technical approaches are both needed in order to minimize the problem. Social approaches are changing the public behaviour by improving community through training and encouragement of partnerships in e-waste management.

Keywords: challenges, developing countries, e-waste generation, informal sector

1.0 Introduction

Hand phones, computers, tablet and more gadgets have been introduced to make an alternative solution for human being. Manufactures such as Samsung, Nokia, Apple and other commercial names in world industrial competes each other in order to attract people to buy their latest electronic product. As the result, a huge number of electric and electronic wastes have been produced at the recovery centres.

This crucial problem has been faced by developed and developing countries. As for develop countries, they already produced and implemented the advanced technologies compared to

developing countries. Their management system and awareness towards this problem becomes an indicator how their countries overcome the e-waste problem. Meanwhile in a developing countries which is mostly in Asian continental, have been operated in manual segregation and treated e-waste in low-cost machinery.

2.0 Challenges

Currently in developing countries, the advanced technology rapidly produced make electronic industry has the short life cycles and rapidly developing technology have led to increase e-waste volumes. The majority of e-waste elements are led to landfills. However, their partial recyclability, due to their material composition along with the unavoidable restrictions in landfills, has led to the development of retrieval techniques for their recycling and reuse. E-waste differs chemically and physically wise from urban or industrial waste. It contains both dangerous and valuable materials that requiring special treatment to avoid harmful environment.

Retrieving the valuable and base metals is possible by recycling but the high labour cost and strict environmental legislation does not fit with developing countries culture. As a result, the e-waste disposal issue has attracted the interest of politicians, non-governmental organization as well. The increasing economic growth is anticipated to reflect higher e-waste production. But it also can reduced e-waste volume since consumer may favour more portable PC solutions having 1-3 kg average weight compared to the stationary computer weighing 25 kg or the stationary computers is expected to be equipped with LCD (Liquid Crystal Display) screens instead of the older CRTs (Cathode Ray Tube) (Gaidajis, Angelakoglou, & Aktsoglou, 2010).

2.1 Awareness of public

As the entire world known, not all citizens in the developing countries has a good education compared to the develop countries. As the facts goes, their treatment and awareness about e-waste approximately was the same. Some of them might be concern about environment but some of them ignore the important of having a healthy surrounding. In developing countries, crude recycling activities has been involved in industrial for a long time and the long term effect to the environment is very crucial. Besides that, implication of the crude activities has been ignored by recycler because they prefer to choose poverty than safety of themselves. This situation happened because of the lack of awareness in government and public about the potential hazards of the present end-of-life (EOL) management e-waste in developing countries (Osibanjo, O., & Nnorom, I. C., 2007).

Furthermore, e-waste became a crucial problem parallel to the improvement of living standards in developing countries. Some high-class residential areas more preferable more packaged products cause the increasing of recycle materials (Dhokhikah, Y., & Trihadiningrum, Y., 2012). According to Ramzy Kahhata *et.al* (2008), European Commission WEEE Directive adopted categories in the directive including awareness of electric and electronic user. One of their aims is to raise the awareness of end-of-life factors during product design. These factors include dismantling of parts and recyclability of materials, proper collection systems that support separate collection of e-waste to reduce disposal in common municipal waste streams, and best practices for treatment, recovery and recycling of e-waste. Besides that, the density and proportion stream depends mainly on level of income and lifestyles, culture and tradition, geographic location as well as dominant weather condition (Khatib, I. A., 2010).

2.2 Informal sector

For the trendy centuries nowadays, informal recycling becomes one of the new environmental challenges of electronic goods. In developing countries, e-waste mostly processed by backyard industries under the most primitive of processed. The competition between formal sector and informal sector create a huge distance in order to manage e-waste in developing countries. This is because informal sector activities in developing countries very active in e-waste recycling chain. Valuable and precious material contained in e-waste stream is their passion to involve more in e-waste recycling chain (Pariatamby, A., & Victor, D., 2013). Waste management also affected by technical factors influencing the system are related to lack of technical skills among personnel within municipalities and government authorities, deficient infrastructure, poor roads and vehicles, insufficient technologies and reliable data (Abarca, L., Maas, G., & Hogland, W., 2013).

Besides that, their participation in mostly in waste recycling as itinerant waste buyers, street pickers, dump pickers, truck pickers, workers in junk shops, or processors of waste materials. The reason they are willing to involve in industry is driven by the profits made from the resale of recovered materials. Many developing nation cities remain centre of material recovery and reuse through the participation of people who scavenge goods from city waste and resell the materials to manufacturers. The incentive to collect recyclable material is economic. Because their wages come from resale, and not through contracts with the city, informal sector recycling is a free service provided to the municipality (Vergara, S. E., & Tchobanoglous, G., 2012).

2.3 Financing

Money was one of the main major obstacles in developing countries. Whether it is low technology or high technology yet it still need some money to achieve a better result. The Ministry of Financial in developing countries need to think carefully to divide the money into

development, technology as well as for citizen. Part of the problem regarding to the financial is a lack of funds and investment to finance formal recycling infrastructures and the absence of appropriate legislation to deal with the issue. As example in develop countries applied an EPR which contains two difficulties.

The first difficulties is in the government collecting funds from producers or imports if the goods are smuggled into the country, or if the small, sop-assembled products have a large share of the market. Besides that, the second difficulty is in systems that create incentives for collectors and recyclers to over-report the amount of e-waste collected to gain extra subsidies from the fund (Sunil Herat and P Agamuthu., 2012). a lack of financing and the mismanagement of financial resources remain the main challenges to the solid-waste disposal problem in economically developing countries. According to the World Bank, up to 3% of a country's GNP (Gross National Product) can be realistically spent on environmental protection. For that reason, the period of time required to generate the capital investments to meet the international standards in low-GNP countries (especially GNP < US $3000 per capita) exceeds by far the economic life span of treatment plants and infrastructure (Kanat, G., 2010).

3.0 Current waste generation in several developing countries

India is one of the country that facing e-waste problem. Lack in knowledge and financial problem also leads to the e-waste productions. Therefore, most of the e-waste treatment carried out by backyard operations (Gidarakos, E., et al, 2012). Most of Asian countries has not been invented a high technology to treat e-waste, but India has been installed about 11 million units of PC and the penetration rate to nearly 11 PC per 1000 inhabitants (Gidarakos, E., et al, 2012). India has been one of selected countries which other countries imported of their used e-waste with an estimated 50 K tonnes every year (Ongondo, F. O., et al, 2011).

According to other researcher, computer waste generation in India was estimated about 41 to 152 million will become obsolete in 2020 (Sunil Herat and P Agamuthu, 2012). As we can see here, the amount was increasing rapidly proportional to the population in India and the e-waste production will keep increasing if not well-treated. Besides that, the annual growth rate of e-waste in India is approximate to seven to ten percent. This circumstance happens because 80 percent of India's market more into service and commercial in computer and information technology (IT) hardware. (Dwivedy, M., and Mittal, R. K., 2012).

Other than India, China is the world's largest exporter of electronic goods. In China market, the electric and electronic equipments were imported in two ways either legal or illegal. In 2009, computers waste in China around 12 million units and surprisingly increased more than 70 million units in 2010 (Ongondo, F. O., et al, 2011).

Furthermore, around 1.33 billion populations in China and estimated about 1.1 million ton of e-waste productions in China and therefore due to rapid advanced technologies as well as shorter lifespan of electronic can contribute to the e-waste stacks (Jin, G. Q., et al, 2012). By 2020, e-waste from old computers will have increased by 200 % to 400 % from 2007 levels in China. China's government has banned all the imported wastes to their country, but China still remain as the major e-waste dumping ground (Liu, Q., et al. 2012).

Meanwhile in Thailand, the number of computers in households increased more than fourfold, from 0.8 to 4.5 million units (Manomaivibool, P. and S. V., 2011). In Thailand itself have been estimated of having electric and electronic manufactures around 2000 and makes it one of the largest manufacturers in the region (Sunil Herat and P Agamuthu, 2012. Since Thailand has a very large numbers of manufactures, absolutely the demand of electric and electronic equipments keep raising. In this context, e-waste generation is expected to reach 25

million units equivalent to 180,000 tonnes by 2020 and for industrial e-waste, has been estimated to be around 11,000 tonnes per year (Manomaivibool, P. and S. V., 2011).

Brazil is one of the countries that having a nightmare about e-waste production. After China, Brazil generates a lot of computer scrap as the second among emerging countries (Schluep, M., et al, 2009). Brazil is the fifth place in production of computers because of electric and electrical equipments is the most popular sector which also placed Brazil in a standout position in market about 4.1% of gross domestic product (Guimarães, M., et al, 2012). As the large biodiversity in the world, the Brazilian population represents a growth rate of 1.17% which to be estimated about 191 million people. Since the population growth was higher from each year to another year, predicted a large amount of people anticipated to access computer too. From this situation, we can predict at least 10 years ahead, the quantity e-waste production in Brazil would be greater if it is not treated well from now on (Reis, C., et al, 2012).

Based on Environmental Quality Report (EQR) (DOE, 2009), there was 1.305 million metric tonnes of waste generated on 2008 and the waste was increasing within a year in 2009 about 1.705 million metric tonnes of waste generated. Based on Environmental Quality Report (EQR) (DOE, 2010), there was 1.705 million metric tonnes of waste generated on 2009 and the waste was increasing within a year in 2010 about 1.880 million metric tonnes of waste generated. Based on Environmental Quality Report (EQR) (DOE, 2011), there was 3.087 million metric tonnes of waste generated on 2010 and the waste was increasing 6.29% within a year in 2011 about 3.281 million metric tonnes of waste generated. Based on Environmental Quality Report (EQR) (DOE, 2012), there was 3.281 million metric tonnes of waste generated on 2011 and the waste was decreasing 13.01% within a year in 2012 about 2.855 million metric tonnes of waste generated. There are several facilities for handling scheduled

wastes such as on-site treatment, Kualiti Alam Sdn. Bhd and more. Every of each year, the increasing of amount of e-waste is parallel of increasing recovery facilities.

Table 1: Facilities Handling Scheduled Wastes, from 2009 until 2012 (DOE, 2009 - 2012)

No	Facility	Metric Tonnes (2009)	Metric Tonnes (2010)	Metric Tonnes (2011)	Metric Tonnes (2012)
1	Local Off-site Recovery Facilities	686,011.92	875,972.38	937,769.83	596,527.89
2	On-site Treatment	520,751.65	805,365.94	340,460.16	674,332.66
3	Special Management	293,782.21	Not stated	1,659,537.67	Not stated
4	Kualiti Alam Sdn. Bhd	126,288.00	133,674.17	119,684.03	105,151.05
5	On-site Storage	47,039.37	35,456.96	189,861.05	294,618.67
6	Off-site Clinical Waste Incinerators	16,558.99	16,781.08	17,795.47	18,055.03
7	Trikenes (Sarawak) Sdn. Bhd.	12,043.00	12,161.00	14,500.00	15,878.33
8	Foreign Facilities (Export)	2,833.00	1,517.00	1,961.00	4,145.10
	Total	1,705,308.14	1,880,928.53	3,281,569.21	1,708,708.73

Table 2: Off-site Recovery Facilities and Quantity of Waste Handling, from 2009 until 2012 (DOE, 2009 - 2012)

Waste category	Recovery facility (2009)	Recovery facility (2010)	Recovery facility (2011)	Recovery facility (2012)
Electronic and electrical wastes	138	153	158	153
Dross / Ash / Slag / Catalyst	39	50	50	57
Oil / Mineral Sludge / Spent Coolant	34	38	38	58
Acid / Alkaline	29	37	28	27
Heavy Metal Sludge / Rubber	28	30	30	37
Used container / Contaminated waste / Ink / Paint / Lacquer	31	28	37	34
Solvent	22	23	23	31
Photographic	10	15	10	12
Phenol / Adhesive / Resin	9	10	15	23
Battery	7	8	7	7
Gypsum	4	7	8	7
Total	351	399	404	446

4.0 Conclusion and discussion

Most of developing countries faced the same e-waste management problems. Level of awareness from public is very low because they do not know how to manage e-waste respectively. Campaigns and activities related towards sustainable and greener world need to be intensified in order to attract people joined. Furthermore, the existing of informal sector should not be underestimated because they are the pillars of e-waste recycling in most of developing countries. Government and industrial sector should be work together to have a win-win situation regarding of e-waste. Besides that, financing remains as one of the

challenges in order to achieve greener world. This is because all the machinery and stuffs are demanding large money to buy it. Cooperation from all level of public is welcome to support the industrial e-waste sector.

Summarizing all above, from initial of e-waste separation until the treatment is essential. The treatment should be undergoes in a specific treatment in order to get the valuable material from e-waste. Skilful person are most welcome to serve in e-waste industrial.

References

Abarca, L., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, *33*(1), 220–232. doi:10.1016/j.wasman.2012.09.008

Dhokhikah, Y., & Trihadiningrum, Y. (2012). Solid Waste Management in Asian Developing Countries : Challenges and Opportunities, *2*(7), 329–335.

Dwivedy, M., & Mittal, R. K. (2012). An investigation into e-waste flows in India. *Journal of Cleaner Production*, *37*, 229–242. doi:10.1016/j.jclepro.2012.07.017

DOE (Department of Environment) 2009 *Environmental Quality Report 2009.* DOE, Malaysia

DOE (Department of Environment) 2010 *Environmental Quality Report 2010.* DOE, Malaysia

DOE (Department of Environment) 2011 *Environmental Quality Report 2011.* DOE, Malaysia

DOE (Department of Environment) 2012 *Environmental Quality Report 2012.* DOE, Malaysia

Gaidajis, G., Angelakoglou, K., & Aktsoglou, D. (2010). E-waste : Environmental Problems and Current Management, *3*(1), 193–199.

Gidarakos, E., Dimitrakakis, E., Basu, S., Johri, C. R., & Rajeshwari, K. V. (2012). E-waste recycling environmental contamination : Mandoli , India. *Waste and Resource Management*, *165*, 45–52.

Guimarães, M., Magrini, A., Fernando, C., & Bilitewski, B. (2012). A model for estimation of potential generation of waste electrical and electronic equipment in Brazil. *Analysis*, *32*, 335–342. doi:10.1016/j.wasman.2011.09.020

Jin, G. Q., Xi, K., & Li, W. D. (2012). Sustainable Information Management for Waste Electrical and Eletronic Equipment, 875–881.

Kahhat, R., Kim, J., Xu, M., Allenby, B., Williams, E., & Zhang, P. (2008). Resources , Conservation and Recycling Exploring e-waste management systems in the United States. *Conservation And Recycling*, *52*, 955–964. doi:10.1016/j.resconrec.2008.03.002

Kanat, G. (2010). Municipal solid-waste management in Istanbul. *Waste Management*, *30*(8-9), 1737–1745. doi:10.1016/j.wasman.2010.01.036

Khatib, I. A. (2010). Municipal Solid Waste Management in Developing Countries : Future Challenges and Possible Opportunities.

Liu, Q., Shi, S. J., Du, L. Q., Wang, Y., Cao, J., Xu, C., … Hecker, M. (2012). Environmental and health challenges of the global growth of electronic waste. *Science of the Total Environment, The*, 2460–2462. doi:10.1007/s11356-012-0923-z

Manomaivibool, P. and S. V. (2011). Responsibility in Thailand. *Journal of Industrial Ecology*, *15*(2), 185–205. doi:10.1111/j.1530-9290.2011.00330.x

Ongondo, F. O., Williams, I. D., & Cherrett, T. J. (2011). How are WEEE doing ? A global review of the management of electrical and electronic wastes. *Waste Management*, *31*(4), 714–730. doi:10.1016/j.wasman.2010.10.023

Osibanjo, O., & Nnorom, I. C. (2007). Waste Management & Research. *Waste Management & Research*. doi:10.1177/0734242X07082028

Pariatamby, A., & Victor, D. (2013). Policy trends of e-waste management in Asia. *Journal of Material Cycles and Waste Management*, *15*(4), 411–419. doi:10.1007/s10163-013-0136-7

Reis, C., Oliveira, D., Moura, A., & Engel, A. (2012). Collection and recycling of electronic scrap : A worldwide overview and comparison with the Brazilian situation. *Waste Management*, *32*(8), 1592–1610. doi:10.1016/j.wasman.2012.04.003

Schluep, M., Hagelueken, C., Kuehr, R., Magalini, F., Maurer, C., Meskers. C, Mueller, E, Wang, F. (2009). Sustainable Innovation and Technology Transfer Industrial Sector Studies. *Recycling from E-Waste to Resources.United Nations Environment Programme & United Nations University*, p.120.

Sunil Herat and P Agamuthu. (2012). Waste Management & Research. *Waste Management & Research*, (July). doi:10.1177/0734242X12453378

Vergara, S. E., & Tchobanoglous, G. (n.d.). *Municipal Solid Waste and the Environment : A Global Perspective*. doi:10.1146/annurev-environ-050511-122532