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Research paper

Strategies to manage electronic waste approaches: an overview in Malaysia

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Abstract

The issue of e-waste is becoming an increasingly threatening problem as it contains many toxic materials that can severely harm both human beings and the environment. This problem is expected to worsen if not serious efforts are taken to manage this e-waste. The current paper introduced quantity of e-waste generated and their negative impact on both environment and human beings in some countries including Ma-laysia. It also presents the managerial efforts taken in this regard to deal with the e-waste. The current study is an effort to decrease the dan-ger and solve e-waste problems. For that, it utilized different tools such as LCA, MFA, MCA and EPR. Over and above all of these, no matter how well the policies are introduced and implemented benefits will only arise provided end users are prepared to accept introduced policies and adhere to them.

Keywords: *Electronic Waste; Strategies to Manage E-Waste; Waste Management.*

1. Introduction

The current study maintains that one of the most important objective to be taken into consideration while establishing an e-waste management is to create a society that understands the importance of ecological recycling and adhere to specific regulation in this regard. In Malaysia, hazardous waste management programs started in 1989 because of the rapid development in industrial activities generated various waste products and materials. The effective implementation of policies and strategies is required to minimize the environmental and health risks caused by such complex hazardous wastes (Suja et al., 2014). The issue of e-waste in developing countries is not as dangerous as it other developed countries. This is true because there is a smaller number of electronic devices comparing to the developed countries and these electronic good have a considerable longer half-lives. The most dangerous problem in this regard is the shipping of second hand electronic devices from developed to developing countries. These devices forming 80% of the western e-waste are being exported to developing countries (Hicks et al., 2005). This situation has led to many health and environmental problems in the developing countries especially with the lack of policies, rules and regulations to safely manage these imports. Alias et al. (2014) reported that e-waste is a threating problem to human health. The problem of e-waste is one of most rapidly growing problems around the world. Due to the rapid electronic growth, new technologies substitute older ones resulting in the disposal of huge amounts of e-waste in landfills ignoring the negative impact this has on the environment. In the recent 20 years, it has been witnessed that newer technology known as the "smart" generations with smart functions is causing previous electronic devices to get old and obsolete. This is true in the case of many electronic devices which were replaced with ones of better designs. An example fort that would be the lifespan of computers that became around 2 years in 2005 after being 4.5 in 1999 (Widmer et al., 2005). This incident resulted in a huge amount of computers' e-waste either disposed or exported to developing countries. It is not an easy job to known exactly the amount of e-waste generated around the world. One of the efforts in this regard, as illustrated in Table 1, is the study by Bushehri (2010) which provided estimations of the amounts of e-waste between the years 1997–2010 in some countries such as China, Malaysia, Japan and the US.

Table 1: The Quantity of E-Waste Generated in the Malaysia, United States, China and Japan

Countries	Products	Quantity-million	Classification	Years	References
Malaysia	Computers	1.11	E-waste	2008 - 2020	Perunding Earth Sdn Bhd(2009)
United States	Computers	500	E-waste	1997 - 2007	Bushehri(2010)
China	Computers	5	E-waste	Every Year	Hicks et al.(2005)
Japan	Computers	610	E-waste	2010	Bushehri(2010)

Source: Kiddee Et Al., 2013.

The study estimates that over 130 million computers, monitors and televisions become obsolete annually and that the annual number is growing in the United States (Bushehri, 2010). Around 500 million computers became obsolete between 1997 and 2007 in the United States alone and 610 million computers had been discarded in Japan by the end of December 2010. In China 5 million new computers and 10 million new televisions have been purchased every year since 2003 (Hicks et al., 2005), and around 1.11 million tons of e-waste is generated every year, mainly from electrical and electronic manufacturing and production processes, end-of-life of household appliances and information technology products, along with imports from other countries. It is reasonable to assume that a similar generation of e-waste occurs in other countries. A studied done by Norazli et al. (2015) predicted that the lifespan of electric and electronic appliances usage by Malaysian were around 0 to 15 years. This prediction had been proved by previous study in 2013 which resulted that 73% of Malaysian will phased out their electric and electronic appliances within 10 years either it's broken, malfunction or demanding for newer technology (Afroz et al., 2013).

Recycling of e-waste can also distribute hazardous substances into the environment and may affect human health. While there are more than 1000 toxic substances (Puckett and Smith, 2002) associated with e-waste, the more commonly reported substances include: toxic metals (such as barium (Ba), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), lithium (Li), lanthanum (La), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), silver (Ag), hexavalent chromium (Cr(VI)) and persistent organic pollutants (POPs) such as dioxin, brominated flame retardants (BFRs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), polybrominated dibenzo-p-dioxins and dibenzofurans (PBDD/Fs), Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and polyvinyl chloride (PVC).

E-waste in Malaysia normally coming from several sources namely industrial, household and business entities. Currently only e-waste generated from industries implemented a proper management of e-waste. Department of Environment Malaysia (DOE) recorded the generation of e-waste from the industrial sector between year 2009 and 2010 with amount 134,035.70 metric ton and 163,339.80 metric tons (Idris, 2012). E-Waste in Malaysia is handled by the licensed recovery facilities. However, there are issues faced by the recovery facilities in achieving the goal of converting e-waste into a source material (Suja et al., 2014).

E-waste constituents fluctuate according to the manufactured goods and contain more than 1000 diverse substances, which fall under 'hazardous' and 'non-hazardous' categories. Broadly, it includes ferrous and non-ferrous metals along with the plastics, glass, wood and plywood, printed circuit boards (PCB), concrete and ceramics, rubber and other items. E-waste comprises of about 50% of iron and steel followed by plastics (21%), non-ferrous metals (13%) and other constituents. Non-ferrous metals consist of precise metals such as copper (Cu), aluminum (Al) and precious metals, e.g. silver (Ag), gold (Au), platinum, palladium, etc (Widmer et al., 2005). Beyond verge quantities of elements like lead, mercury, arsenic, cadmium, selenium and hexavalent chromium and flame retardants of e-waste classifies as hazardous waste (Toxic links, 2003). A study by Grant et al. (2013) reported the relationship between the e-waste exposure and its related health consequences. The health consequences are mainly physical health outcomes such as thyroid function, reproductive health, lung function, growth, and changes in cell functioning. The brominated flame retardants present in the plastic part of e-waste have adverse effects on nervous system and interfere with fertility in mammals. Lead component, mostly present in Cathode Ray Tube (CRT) of old television, lead–acid batteries, cable sheathing and solder of printed circuit board is responsible for symptoms like vomiting, diarrhea, convulsions, coma or even death. Exposing to cadmium can cause acute and chronic toxicity and causes flu-like symptoms (Grant et al., 2013). The Malaysian DOE defines E-waste as "wastes from the electrical and electronic assemblies containing components such as accumulators, mercury switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl's" (Malaysia DOE, 2010).

2. Malaysia scenario and management

Malaysia is witnessing a rapid development in all fields. It has a population of 29.9 million and is listed as the 41th populated country in the world with land size of 330,800 sq km (World Bank, 2009). It is predicted that Malaysia will be one of the major producers of technology and electronics by the year 2020 which makes Malaysia as the leading countries in e-waste generation. The average of the population increase is estimated as from 0.4 million to 0.7 million per year (Alias et al., 2014). International Labor Office Geneva (ILO) mentions that the increase of the Malaysian population results in a rapid consumption of electronic devices leading to a more generation of e-waste. In 2005, the Electronic waste management was developed and monitored under the Department of Environment Malaysia (DOE). E-waste refers waste materials from the electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode ray tubes and other activated glass or polychlorinated biphenyl capacitors or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl (DOE, 2010).

As per listed under Environmental Quality (Schedule Waste) Regulations 2005, e-waste was categorized to three different code which are SW 103 for batteries waste containing cadmium and nickel, SW 109 for waste containing mercury and it's compound and SW110 for other e-waste assemblies including printed circuit board, electronic components and wires (DOE, 2010). Back in 2007, the e-waste generation in Malaysia was estimated by Perunding Good Earth Sdn Bhd under the management of Department of Environment Malaysia (DOE). The inventory calculated and projected the future generation of e-waste in Malaysia. By year 2020, Malaysia was estimated to generate 1,119,155 metric tons of e-waste. The StEP (Solving the E-waste Problem) organization had published a data from 184 countries on e-waste generation. The latest amount recorded for generation of e-waste in Malaysia for 2014 alone was 232,000 metric ton (StEP, 2015). Therefore, it is not possible to achieve the estimation of projected total with 690,827,529 metric ton of e-waste generation by year 2008-2020 (Perunding Good Earth Sdn Bhd, 2009).

The main reason behind this increase of e-waste is the high demand on the production of electric and electrical equipment from the Malaysia's consumers. In addition, Malaysia is an attractive country for the illegal dumping of e-waste. The geographical position of Malaysia is playing a role in this as it lies in the middle of international e-waste trade route 23. The development of small-scale and informal recycling processes has also increased the potential of serious adverse impacts on the environment and public health (Fatihah et al., 2014). See figure 1.

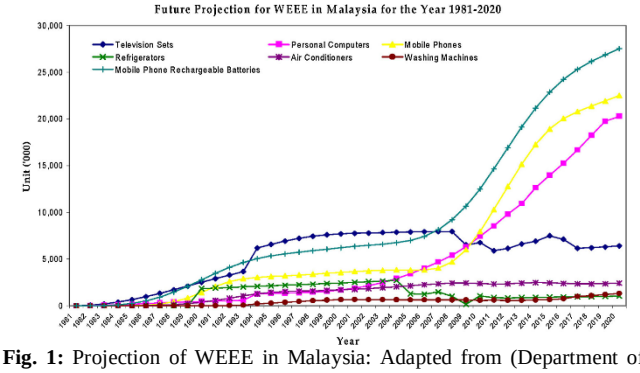

Fig. 1: Projection of WEEE in Malaysia: Adapted from (Department of Environment, 2009).

In response to the flood of imported e-waste, on 5 May 1992, Malaysia has ratified the Basel Convention, a global agreement regulating movement of hazardous wastes which targets to safeguard human health and the environment from the adverse impacts of toxic waste. Malaysia is one of the 166 parties to the convention (as of Nov, 2005). In addition, the Royal Malaysian Customs (RMC) is responsible for managing the trans boundary movements of hazardous waste under the Customs Act, 1967, specifically, the Custom (prohibition of Import) Order 2008 and the Customs (Prohibition of Export) Order 2008 . Through the prohibition of imports and exports of waste, RMC is able to prevent any illegal trafficking of hazardous waste, such as e-waste.

3. Strategies to manage e-wastes

It is known that the rapid increase of e-waste in huge amounts is the financial development as well as the growth in technology innovation. These factors are widening the range of technology expansion. Buying such products makes it natural for the e-waste to appear (Kang and Schoenung, 2005). Nowadays, the e-waste managements all over the world has this assessment to alleviate the dangers of this waste. Much research is done on e-waste all over the world trying to find the most suitable ways of alleviating the dangers of this e-waste. The following sections illustrate various tools utilized for helping research in the area of e-waste management. These tools are LCA, MFA, MCA and EPR. Research includes the idea of recycling especially for the precious materials.

3.1. Life cycle assessment (LCA)

LCA is an assessment that aims at designing environment friendly devices that can be used to decrease the level of e-waste. This is a result of much research that have boon conducted since 1990s. This research resulted in the development of gadget similar to the eco-outline that is advanced with natural effects. A device that is well-designed which is a more environment friendly would be an option that attracts buyers. LCA was proved to be a health instrument as it has a positive impact on the environment creating eco-plan items (Kiddee et al., 2013). Life Cycle Assessment is considered an effective methodology to be used by firms as a means of monitoring the e-waste in all of its stages (Hong et al., 2015).

3.2. Material flow analysis (MFA)

MFA is a method used for studying the course of materials when moved to other locations for reuse. This method takes into considerations the space and time. It works by connecting certain pieces of information like foundations, paths, intermediary and last endpoints of the gadget. MFA is a good instrument for health environment and waste administration (Kiddee et al., 2013). Streicher-Porte maintained that combining this instrument with financial assessment can be fruitful.

3.3. Multi-criteria analysis (MCA)

MCA is a technique of managing and resolving the related problems. It provides an allowance for judging and resolving complicated problems (Kiddee et al., 2013). Garfi et al. (2009) defines these techniques as a tool of "decision-making" that helps in taking critical decisions and in solving complex problems including the qualitative/quantitative aspects of the problem. MCA technique has been used a wide range of applications. Some of these applications are environmental problems with a special attention to energy consumption (Horie, 2004) Environmental impacts (Belboom et al., 2011) Washing machines Eco-design (Park et al., 2006) IT and telecommunications equipment Printers Product development (Pollock and Coulon, 1996).

3.4. Extended producer responsibility (EPR)

Crediting the obligation to producers in retrieval of items is a strategy methodology that falls under the view of contaminator-compensations standards (Kiddee et al., 2013). According to the EPR environment policy approach, it is the responsibility of the manufacturers to collect back their products after being used. This policy includes the polluter-pays principles (OECD, 2001; Widmer et al., 2005).

4. E-waste implications, discussion and strategies in Malaysia

Many efforts were conducted in Malaysia to manage this problem but still there is a need more studies and research in this area. This is true because there are still some hurdles and problems when it comes to the management of the dangerous end-of-life of electrical and electronic. One of the factors that can negatively affect the environment is the absence or the low level of base data for e-waste composition such as glass, metals, plastic and others. Other factors are represented by the lack of reliable data on the functions of e-waste and the shortage of recycling infrastructures. In this regard, Institute of the Advanced Study of Sustainability, United Nations (UNU-IAS) reported that Malaysia is one of the countries that still need to have clear national regulation concerning the e-waste. It is observed that the technology in Malaysia in this regard is still conventional especially when it comes to the recovery of precious metal. Wet chemical processes, air separation and thermal, electrolysis processes are examples of the available technology in the treatment facilities. These components need to be upgraded effectively to deal with the growing e-waste pollution. Malaysia is taking precautions and is working hard in this field. One of these efforts is the establishment of the Extended Producer Responsibility (EPR) (Agamuthu and Victor, 2011). As mentioned in the Tenth Malaysia Plan, this initiative is taken by Malaysia as a step towards sustainable waste management. Motorola Malaysia, Nokia Malaysia, Dell Malaysia, Apple Malaysia, HP Malaysia, Senheng Corporation and Toshiba Malaysia are some multinational companies which decided to take part in this initiative and initiate the take back scheme. The sole focus of these companied was on the end of life (EoL) and on the field of IT and telecommunication appliances. This is not sufficient in case of Malaysia as other issues related to sustainable e-waste management system need to address. Some of these issues are policy, technology and awareness related obstacles and problems. Fatihah et al. (2014) maintained that the recovery facilities has raised some issues such as the lack of e-waste supply and processing technology. Pariatamby and Victor, (2013) uncovers that the lack of e-waste supplies are due to the lack of skills in e-waste management that comes from household. Another reason for that might be the lack of the awareness by Malaysia citizens. One of the problems causing the pollution of the environment is the lack of management skills in handling the e-waste. This stems from the fact that there is a shortage of treatment facilities and the absence of clear regulation in this regard especially in developing countries. In Malaysia, the heavy metal pollution of e-waste was originated from informal activities and spread out to the environment (Suja et al., 2014).

5. Conclusion

The issue e-waste is a known problem at local and global levels. The origin of this problem can be traced to developed countries but now it seems to be expanding to other countries and regions. The main reason behind the emergence and the expansion of this problem is the consumer technology. Therefore, in this research we proposed some ideas to deal with this problem are developing eco-design devices, collecting e-waste with caution, recovering and recycling materials, disposing e-waste using proper techniques, forbidding the shipping of second hand electronic devices to the developing countries, and raising awareness of the impact of e-waste.

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