Sustainable WEE management in Malaysia: present scenarios and future perspectives

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Abstract: Technological advances have resulted development of a lot of electronic products for continuously increasing number of customers. As the customer taste and features of these products change rapidly, the life cycles have come down tremendously. Therefore, a large volume of e-wastes are now emanated every year. This scenario is very much predominant in Malaysia. On one hand e-wastes are becoming environmental hazards and affecting the ecological imbalance. On the other, these wastes are remaining still economically valuable. In Malaysia, e-waste management system is still in its nascent state. This paper describes the current status of e-waste generation and recycling and explores issues for future e-waste management system in Malaysia from sustainable point of view. As to draw some factual comparisons, this paper reviews the e-waste management system in European Union, USA, Japan, as a benchmark. Then it focuses on understanding the Malaysian culture, consumer discarding behavior, flow of the materials in recycling, e-waste management system, and presents a comparative view with the Swiss e-waste system. Sustainable issues for e-waste management in Malaysia are also presented. The response adopted so far in collection and recovery activities are covered in later phases. Finally, it investigates the barriers and challenges of e-waste system in Malaysia.

1. Introduction
Since 1980’s, massive volume of electric and electronic equipment has been produced, and used or consumed worldwide at a very high rate [11]. The rate of use is rather increasing over the time. However, most of such product’s life cycles are known to have decreased significantly [8]. Subsequently, the ever-increasing amount of waste electric and electronic equipment (WEEE) has become a common concern in many countries in the world[9], from the point of conservation of environment and reuse or recycling of such wastes. This E-waste has become a serious threat to the living environment as more and more appliances are thrown away after usage into bins. Obviously, this leads to toxic pollution, as electronic items break down and release of heavy metals, flame retardants, and other chemicals into soil and water [4]. Effective and efficient e-waste management, considering the social cost and environmental impact recovery seems to be a complex task [18]. However, it depends on the aspects of a particular country from e-waste management, despite the differences in the socio-economic and legal contexts [1].
The methodology of this research consists of the several folds. Data on sales of E&E products and WEEE generation from household and industrial sources were collected. WEEE generation data were collected from the government sources like DOE, Ministry of Natural Resources and others. High ranking journal papers, literatures, e-books, and internet sources and field survey were done as the main sources of information collection on WEEE management activities to portray the future (expected) scenario. To find out the current position of WEEE management in Malaysia, field visit, interview, communication with Manufacturers, end users, DOE and other government agencies, and the relevant local municipalities were contacted. All these information were collected and analyzed to present a comparative picture of the current position in Malaysia to that of a few leading e-waste managing developed countries.

Interviews with the government officials and municipal authorities have given a thorough understanding of the management process and future perspective. People who are in charge of formulating the legislation coupled with a literature search obtained details of the recent progress comparable with other countries.

2. Review of e-waste regulations, laws and systems of various leading countries (Europe focusing on Switzerland, USA, Japan)

2.1. Europe
E-waste management started in European countries under the WEEE directive (2002/96/EC), which was effective from February 13, 2003[15]. It imposes an obligation to the electronic and electronic product manufacturers to take back the end of life products and provide a framework of the various measures for manufacturers including collection, recovery and treatment of WEEE. Switzerland was the first country in the world to develop and implement a well-organized, formal e-waste management system for the collection, transportation, recycling/treatment and disposal of e-waste [17]. The country structured its legal and operational framework based on the Extended Producer Responsibility (EPR)
model where manufacturers and exporters are liable for the physical and financial responsibilities for the environmentally sound handling, recycling and disposal of e-waste [7].

2.2. USA
In the USA, the fastest growing stream of Municipal Solid Waste (MSW) could be e-waste as because people now a days, like to buy, upgrade and discard electronic products [5]. According to U.S Environmental Protection Agency (EPA), about 80-85 percent of end of life electronic products ended up in U.S landfills [16]. US recycling systems vary according to the individual state perspectives. However, more than 20 states have enforced legislation to manage e-waste and most of them are based on extended producer responsibility policy [13] USA is staying behind other developed countries regarding e-waste management regarding structure development and collection. Some states are, however, advanced like in California; a number of companies are working on collection, recovery and reuse of e-waste [10].

2.3. Japan
In April 2001, Japan applied WEEE management regulation to recycle and treat four major electrical equipment wastes specifically air-conditioners, televisions, laundry machines, and refrigerators (including freezers) [5]. Consumers are required to work together with the collection of their WEEE to retailers. The “recycling fee” is introduced as pre-treatment fee and consumers need to agree with that. Additionally, consumers are often charged the transportation fees [6]. This, however, depends on retailers. Institutional and entrepreneurial consumers send their WEEE to retailers along with the pre-treatment fee or they can treat WEEE as industrial waste at their own expense as well. Retailers should have a commitment to accept designated WEEE on the request of consumers. Retailers also have an obligation to transfer the accepted WEEE to the producers’ combined collection points [12].

3. Malaysian E-waste scenario

3.1. Increasing trend of E-waste
Malaysia, as known to all, a fast developing country with a population of about 28 million [2]. Waste generations is learnt to have 0.8 kg waste per capita per day. According to the Department of Environment (DOE), Malaysia has generated 40,000 tons of e-waste in 2006 (NST Online, 2007). The figures below are showing the rapidly increasing trend of E-waste generation 40,000 tons in 2006 to 134,000 tons in 2009. These are the latest data available regarding e-waste at this moment in Malaysia

| Table 1. Quantity of E-waste generated in Malaysia (Source: Department of Environment, Malaysia) |
|---------------------------------------------------------------|
| **Year** | **Amount of Waste (Tons)** |
| 2006     | 40275.20                      |
| 2007     | 52718.20                      |
| 2008     | 102808.50                     |
| 2009     | 134035.70                     |
The volume of e-waste is expected to rise up to 1.1 million metric tons in 2020, at a rate of 14 percent annually, according to the same report. The electrical and electronic items which have shared significantly to the volume of e-waste in Malaysia are television sets and mobile phones.

3.2. E-waste flow stream in Malaysia

Figure 3 shows the general flow of WEEE from the source of generation until the location of disposal is identified in Malaysia. It shows a significant disconnection between the largest sources of WEEE and the DOE-licensed e-waste collectors and processors.

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**Figure 2.** Projection of WEEE in Malaysia: adapted from [3].

**Figure 3:** E-waste flow model in Malaysia (Source: Author).
3.3. Malaysian E-waste scenario in comparison with Switzerland

To understand the current position of Malaysia regarding e-waste management, it is worth to compare with an advanced context. Switzerland is the pioneer, and developed the most successful e-waste system in the world. Table 2 summarizes the characteristics of Swiss e-waste system and compares with the Malaysian one.

| Stakeholders                     | E-waste system, responsibilities and Scenario                                                                 | Malaysia                                                                 |
|----------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| **Government**                   | - The federal government plays the role of an overseer, framing the basic guidelines and legislation.          | - Central government in association with state governments provides the legislative framework. |
|                                  | - Partly contribute to overall control and monitoring activities.                                              |                                                                          |
| **Manufacturers/ Importers**     | - Carry the economic and physical responsibilities of their products.                                           | - Manufacturers and importers do not carry the physical responsibility of the product though some voluntary take back system is being seen as part of corporate social responsibility. |
|                                  | - PROs (e.g. SWICO, SENS)* have the role of managing the daily operations of the system, including setting the recycling fees, as well as licensing and auditing recyclers. | - No such effort like PRO’s in Malaysia is seen yet.                       |
| **Distributors & retailers**     | - Bear a part of the physical and informational responsibility of the product.                                  | - Some retailers take back old items when delivers new one. On test basis this is running in several parts of the country, however, they are obliged to take back discarded products by law. |
|                                  | - Are obligated to take back products in categories they have on sale, irrespective of whether the product was sold by them, or whether the consumer purchases a similar product as replacement. |                                                                          |
|                                  | - Are responsible for clearly mentioning the amount of the ARF * in the customer invoice.                      |                                                                          |
| **Consumers**                    | - Are responsible, and obligated by law, to return discarded appliances to retailers or designated collection points. | - No recycling fee’s introduced to the customer yet.                       |
|                                  | - Bear the final financial responsibility through the recycling fee on new product purchases.                  | - Are not responsible to return used products by law to the retailers or collection points. |
| **Collection points**            | - Collect all kinds of WEEE free of charge and ensure the safety of the disposed products to prevent pilferage or illegal exports. | - Do not bear financial responsibility in any form.                        |
| (specifically designated locations) | - Must adhere to minimum standards on emissions and take adequate safety measures concerning employee health. | - Collects all of kinds of WEEE, but these points are not available everywhere. |
| **Recyclers**                    | - Need authorization to operate a recycling facility from the cantonal government, as well as a license from the PROs. | - Recyclers need to take adequate safety measures for dismantling operations. |

* ARF: Appliance Recycling Fee
3.4. Collection and recovery activities of e-waste in Malaysia

This study summarized the current e-waste collection activities found in Malaysia and their characteristics in table 3.

Table 3. Summary of the e-waste collection activities and characteristics of e-waste system in Malaysia (Compiled by Author)

| E-waste collection activities     | Characteristics of the collection system                                                                 |
|----------------------------------|----------------------------------------------------------------------------------------------------------|
| DOE licensed contractors         | - Collect industrial waste and send it to the licensed recovery facilities.                               |
|                                  | - They are also supposed to collect household waste but at present they are not working with e-waste from |
|                                  | - household and business entities.                                                                      |
| Retailer’s collection            | - Retailers delivers new one and take back old one.                                                     |
|                                  | - Consumer can carry to the retailer and have a voucher relative to the type and condition of discarded |
|                                  | - items.                                                                                                 |
| Voluntary collection organization| - Collects household e-waste by means of:                                                                 |
| Social organizations             | - Community based recycling programs.                                                                    |
| Environmental working groups     | - Drop box collection system.                                                                           |
| Municipalities                   | - Junk shop collection system.                                                                          |
| Informal scrap collectors        | - Collects e-waste from household consumer and less frequently business/institutional consumers.       |
| Street buyers                    | - Door to door buying system.                                                                           |
| Scavengers                       | - Exact information is available where they sell or treat even not sure whether inside or outside Malaysia.|
| Traditional hawkers “Surat khabar lama” | - Constitutes a large portion of e-waste collection in Malaysia.                                         |
| Manufacturer’s initiative        | - Panasonic manages e-waste produces within their company but not from the external customer. They      |
| Panasonic Malaysia               | - collect and send their e-waste to Alam Flora Sdn Bhd for proper treatment and disposal.               |
| ECOMOTO Take-back                | - ECOMOTO is a popular e-waste management program for Motorola employees and dealers. They initiated   |
| Nokia Malaysia                   | - “20-to-1” trade-in program where the dealers or its employees will get one free battery for every 20 |
| Dell Malaysia                    | - units of used or discarded rechargeable batteries returned.                                           |
| HP                               | - A ‘Take Back’ scheme launched by Nokia Malaysia inspires consumers to join Nokia and take social     |
| Pikom (National ICT)             | - responsibility to dispose used or old mobile phones, batteries and accessories by using designated   |
|                                  | - recycling bins at particular locations in Malaysia.                                                   |
|                                  | - Dell Malaysia introduces a system like, whenever a customer orders a new computer from Dell, an option|
|                                  | - is provided for the old computer to be collected when the new computer is delivered. Since April      |
|                                  | - 2007, Dell Malaysia is collecting used monitors, desktop and notebook computers, printers and        |
|                                  | - accessories. Visiting Penang Island (on 1st November, 2012), a platform is running under the State     |
|                                  | - MPPP/ Dell Computer Recycling Program for used EEE collection from household.                         |
|                                  | - HP introduced a program “HP Planet Partners Hardware Return and Recycling Programme” for its corporate|
|                                  | - customer to easily dispose the used equipment in an environmentally conscious                        |
Electronic waste recovery systems have started in Malaysia recently. Today the electronic waste recycling business is in all areas in developed countries. It is becoming a large and rapidly consolidating business. Their recovery centers collect and treat mainly, computer and TV monitor, computer cover and casing, CPU, PCB board, IC tray, audiovisual components, VCRs, stereo equipment, mobile phones, other handheld devices, white goods like fridge, washing machine, computer components and others that contain valuable elements and substances suitable for reclamation, including lead, copper, and gold.

Currently there are 153 e-waste recovery facilities in Malaysia where 128 facilities are for partial recovery and 25 for fully recovery [14]. The majority of the e-waste management in Malaysia is centered in the Penang state. Figure 4 below shows the countrywide distribution of recovery facilities for E-waste.

![Distribution of recovery facilities for E-waste in Malaysia](image)

**Figure 4.** Distribution of recovery facilities for E-waste in Malaysia (Source: Department of Environment 2012).

4. Current problems and barriers for e-waste management in Malaysia

Current problems and barriers for e-waste management in Malaysia are summarized in table 4.
**Table 4.** Barriers for sustainable e-waste management in Malaysia (compiled by author)

| Barriers for sustainable e-waste management in Malaysia |
|--------------------------------------------------------|
| **Technological**                                     |
| • Recovery technology availability for precious metal is limited and obsolete. |
| • Inappropriate value addition from recycling reuse and remanufacturing. |
| • Eco friendly disposal of e-waste is almost not available. |
| • Information technology adaptation in take back system. |
| **Engineering**                                       |
| • Efficient collection, dismantling, transportation system design and implementation. |
| • E-waste collection center’s to set up at places convenient to consumers before being sent to recovery plants. |
| • Integrated reprocessing facilities are rarely seen. |
| • Probable technically and economically feasible solutions development for every step of e-waste management like recycling remanufacturing etc. |
| • Logistics and transportation difficulties of e-waste especially bulky home appliances such as refrigerators and washing machines. |
| **Social and Policy**                                 |
| • Compulsory requirement of take back scheme through legislation is still to be implemented. |
| • Social organizations initiative for voluntary take back of e-waste is not prevalent. |
| • Consumers are in view to sell the e-waste for material value inside rather than to pay the recyclers for disposal. |
| **Administrative**                                    |
| • Negotiation and settle the responsibility of the process with stakeholders. |
| • Protection of confidentiality of Intellectual Properties of e-waste |
| • Negotiating and fixing the responsibility for the costs incurred. |
| • Define and apply Individual Producer Responsibilities |

5. **Sustainable issues for E-waste management in Malaysia**

We need to consider some issues to make the e-waste system sustainable namely, financial-economic, environment, socio-cultural, and technical aspects. Table 5 presents a synopsis of the sustainable issues in e-waste in Malaysia.

**Table 5.** Synopsis of sustainable issue for e-waste in Malaysia

| Issues                | Synopsis                                                                                                                                                                                                 |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Stakeholders**      | To achieve a sustainable e-waste recycling system in Malaysia involvement of stakeholders is very much crucial. Stakeholders are formal and informal private sector, community, schools and social organizations, NGO’s, Manufacturers, Importers, Retailers, Local council, Consumers, E-waste contractors, Scrap collectors, DOE, NSWMD, MHLG. Local authorities may foster cooperation among the stakeholders to develop a sustainable e-waste system. |
| **Environmental**     | Illegal dumping and landfilling are the key sustainable issues in E-waste Malaysia. Another issues is, environmental toxicity from burning acid bath where materials are directly exposing to the environment from e-waste. So, managing e-waste successfully is vital and will lead to a sustainable environment in Malaysia. |
| **Technological**     | Technology can play a pivotal role towards managing e-waste in Malaysia. The harmful effects from e-waste processing can be minimized by using latest technology while in Malaysia it is limited to wet chemical process and electrolysis. Effects on human and environment can be reduced by applying |
Successful and productive e-waste management has strong economic and environmental significance for sustainable development of a country. In Malaysia, attention is being given for proper e-waste management. Although some recent initiatives have been taken, but a wide scope is left undone compared to several other countries. Collecting household, institutional and other e-wastes in a sustainable manner for recycling is crucial for maintaining its ever-green environment. Land filling of these economically useful materials and environmentally sensitive products cannot be an option any further. Therefore, an integrated system for collection, recovery and remanufacturing is needed to benefit everyone out of the process. It needs assessment, characterization of materials, investigation for recycling potential, optimization of recycling, shaping the behavior of stakeholders and so on. Researches are needed on these aspects. Enforcing legislation has much importance to frame all the stakeholders’ role in a system and define individual responsibilities. On the other hand cost effective and environment friendly technologies are also needed to introduce in recycling processes. Finally, stakeholders have to be proactive and change their traditional viewpoint of making money from end of life products to save the environment they have to live in.

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