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Survey and analysis of public knowledge, awareness and willingness to pay in Kuala Lumpur, Malaysia – a case study on household WEEE management

Rafia Afroz [a,*], Muhammad Mehedi Masud [b], Rulia Akhtar [a], Jarita Bt Duasa [a]

[a] Department of Economics, Faculty of Economics and Management Science, International Islamic University Malaysia, 50728 Kuala Lumpur, Malaysia
[b] Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia

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ABSTRACT

The main objective of this study is to evaluate public knowledge and awareness about the impact of waste from electrical and electronic equipment (WEEE) on health and environment, their willingness to pay (WTP) for improving WEEE management in Kuala Lumpur, the household electric and electronic equipment's (EEE) product lifetime, the reasons to update, and the deposit and disposal processes of WEEE, and to discuss these results within the context of proper management of WEEE. The data and information used in this study were collected by distributing questionnaires randomly in 5 residential areas in Kuala Lumpur, and interviewing 350 households. The results indicate that the majority of the households (59%) have knowledge about the environmental and health impacts of WEEE. More than half of the households (65%) stated that they considered the environmental factors when they purchased EEE for domestic use. Unfortunately, despite their knowledge about WEEE, only between 2% and 3% of the households were involved in the recycling of their WEEE. However, 52.5% of the households were willing to pay for improving WEEE management system in Kuala Lumpur. This study suggested that the government could manage the WEEE by passing effective legislations; setting up convenient collection centers for proper disposal of WEEE; and organizing campaigns, seminars and workshops to increase the level of awareness of the households and to motive them to recycle their WEEE.

1. Introduction

The waste from electrical and electronic equipments (WEEE) is growing rapidly all over the world (Nnorom and Osibanjo, 2008; Jain and Johri, 2008; Cui and Forssberg, 2003) with a growth rate of 3–5% per year (Mohan et al., 2008). Most developed countries are successfully managing the WEEE by formulating effective legislations, developing recycling infrastructures, and strictly adhering to the principle of extended producer responsibility (EPR) to command electronic manufacturers and importers to take-back used electronic products. EPR was first established in Germany in 1991 by the passage of the "Ordinance on Avoidance of Packaging Waste" (Kibert, 2004). Organization for Economic Cooperation and Development (OECD) and European Union (EU) considered EPR as one of the most potent ways to stem the increasing generation of waste and pollution. It has been renowned as a concept which alters the balance of responsibility among the actors involved in the entire life cycle of a product (Langrova, 2002). This policy mainly focuses on the disposal of the product.

On the other hand, the management of WEEE has become an environmental concern in developing countries due to illegal import or smuggling of WEEE, rapid growth of domestically generated WEEE, lack of prevention and minimization strategies, indiscriminate dumping and improper disposal of WEEE, low awareness in the society about the environmental and health impacts of hazardous substances of WEEE, and tracking down illegal WEEE recycling operators. For this reason, change in attitudes of the governments, appropriate legislations related to WEEE, control of WEEE dumping, implementation of EPR, and transfer of technology on effective recycling of WEEE have become the major issues in the sustainable management of WEEE in developing countries.

On account of the increasing urban population and the pursuit of modern lifestyles (due to economic conversion from agricultural-based to industrial-based socio-economies in the 1980s), Malaysia is facing problems with rapid growth of domestic WEEE volume which is generated from households, business entities, and institutions. Fig. 1 presents the WEEE generation in Malaysia, which

* Corresponding author. Tel.: +60 3 61964789.
E-mail addresses: rafia@iium.edu.my, rafia_afroz@yahoo.com (R. Afroz).

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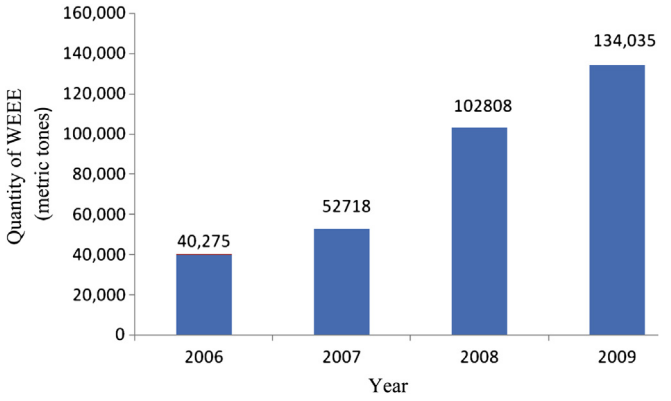

Fig. 1. Quantity of WEEE generated in year 2006–2009. Source: E-waste Inventory Project in Malaysia Report, 2009.

indicates an increasing trend. Malaysia is an attractive country for the smugglers of WEEE because it lies in the middle of the international WEEE trade route (Puckett et al., 2002). For this reason, it is facing the problem of illegal shipments of WEEE from other countries. Also there is evidence of indiscriminate dumping and improper disposal of WEEE. The development of small-scale and informal recycling processes has also increased the chances of serious adverse impacts on the environment and public health. These informal processes attract materials from most of the WEEE generated and thereby become a barrier to the formal and proper recycling businesses. The importance of establishing a regulated WEEE management framework has been recognized but the progress with regard to legislation, the collection system, and the construction of formal recycling facilities is slow in Malaysia. In response to this, Malaysia introduced the first WEEE law – the Environmental Quality (Scheduled Wastes) Regulations 2005 – in August 2005. But public's knowledge, awareness, and willingness to pay for improving the local environmental quality have a vital role in the implementation of the legislation introduced by the government. Afroz and Masud, 2010 assessed the public's perception of the local environmental quality, environmental awareness, and environmental performance and their willingness to pay for improving waste management in Kuala Lumpur, Malaysia. The findings of this study show that the level of awareness of the households about the negative impact of improper waste management is low in Malaysia, compared to other developed countries of the world. In such a situation, there is urgent need for the society to see and comprehend what is really happening with the WEEE in Malaysia. Therefore, in this study, the details of recent legislation responses to WEEE management were obtained through interviews with the officials who are in charge of drafting the various pieces of legislation. Literature search was also carried out to compare Malaysian legislation with other international developments in WEEE management. Furthermore, this study conducted a survey in five residential areas in Kuala Lumpur to investigate the public's knowledge and awareness about the impact of WEEE on health and environment, their willingness to pay (WTP) for improving WEEE management in Kuala Lumpur, the household electric and electronic equipment (EEE) product lifetime, the reasons to update and the deposit and disposal processes of WEEE, and to discuss these results within the context of correct management of WEEE. In this paper, Section 2 discusses the international development of WEEE management, Section 3 analyzes the legislation response to WEEE management in Malaysia, Section 4 presents the flow of used EEE in Malaysia, Section 5 discusses the implementation of EPR in Malaysia to manage the WEEE, and Section 6 details the methodology used to conduct the survey in Kuala Lumpur. Lastly, Sections 7 and 8 discuss the results, discussion, and conclusion, respectively.

2. International development of WEEE management

Globally, numerous legal frameworks are enacted and implemented to control WEEE (Wath et al., 2011). The Basel Convention is officially known as the 'Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal'. It is the most inclusive worldwide environmental agreement on hazardous wastes (www.basel.int). The main objective of the Basel Convention is to defend human health and the environment from undesirable impacts of WEEE. It came into force on 5 May 1992 in accordance with article 25(1) of the Convention. The European Union (EU) tried to protect the environment from adverse impact of WEEE based on two important directives, the WEEE directive and the Restriction of Use of Certain Hazardous Substances (RoHS) in EEE Regulations directives. Many countries of the world followed the WEEE Directives (2002/96/EC) with detailed guidelines to enable the producers and consumers to appreciate their duty to manage WEEE in an environmentally sound manner (EU, 2003).

2.1. USA

USA Environmental Protection Agency has started a green National Electronics Action Plan (NEAP) to address the environmental concerns of electronics. The range of NEAP is restricted to computers, televisions, and cell phones. But, USA has not established the Basel Convention. Likewise, there is no federal legislation for handling WEEE collection, disposal, and export. Meanwhile, in the last couple of years, many states in USA have taken efforts for collection and recycling of WEEE from residential and commercial consumers in environmental friendly manner (EU, 2003). The state of California has announced a law for collecting the Advance Recycling Fee (ARF) from the consumer during the purchase of a new product. These charges can range from $6 to $10 for EEEs such as TVs, computers, and monitors (Gregory and Kirchain, 2007).

2.2. UK

In UK, the parliament passed the legislation as EU directive to control the WEEE in 2007. The legislation has delegated the responsibility to the operators (private sector) to report, finance, and control the treatment of WEEE under producer compliance schemes. The producers, preprocessors, and exporters need to pay registration fees as operational costs for running the scheme. They have to ensure that the WEEE, selected from different sources, must be treated by using the best available treatment, recovery, and recycling techniques (Turner and Callaghan, 2007).

2.3. India

In India, the Ministry of Environment and Forests (MoEF) is the national authority responsible for formulating legislations related to waste management and environmental protection. MoEF has approved the guidelines to identify the various sources of WEEE in India and prescribed procedures for handling WEEE in an environmentally safe manner (MoEF, 2008). However, there is no appropriate law or regulation to specifically address the WEEE problem in India. At present, most of the hazardous materials found in WEEE are covered under the purview of "The Hazardous and Waste Management Rules, 2008" in the category of "hazardous" and "nonhazardous" waste (MoEF, 2008).

2.4. China

In China, the WEEE is controlled by the Administration of Control of Pollution affected by EEE products. Consequently, the manufacturers of EEE are mandated to manufacture EEE according to national industrial standards (Wath et al., 2011). The importers, sellers, and manufacturers are under provision for fine if they fail to fulfill the established standards (GOM (Government of Malaysia), 2007).

2.5. Developing countries

Developed countries such as USA, Canada, and Japan are dumping their WEEE in developing and Eastern European countries (Oh and Thompson, 2006; BAN, 2005; BAN/SVTC, 2002). This is very detrimental for the environment and human health in these countries, which is not being considered by the dumping countries. Most of the developing countries do not have proper technology, formal government-driven or nongovernment-driven legislation, or EPR program for WEEE management. For example, Pakistan has no regulations to manage WEEE, although its National Environment Policy has been active since 2005. Therefore, its citizens have to manage WEEE in different ways. The informal recycling sector effectively survives by dismantling electronic scrap and extracting valuable metals from WEEE. In Thailand, public awareness about WEEE is low. They have incomplete databases and there are no inventories related to WEEE; no formal laws and regulations exist to manage WEEE. In order to overcome this situation, the Thai government approved the National Strategic Plan on Integrated Management of WEEE (WEEE Strategic Plan) in July 2007. In Vietnam there are currently no laws or regulations related to WEEE. There is also no inventory of WEEE (Herat and Agamuthu, 2012) in this developing country. The reasons behind this situation are unwillingness of users for the payment of disposal, lack of awareness among users, the threats and risk of WEEE faced by collectors and recyclers of WEEE, and lack of funds and investments (Nnorom and Osibanjo, 2008). But there are some exceptions, such as in Bangladesh and Philippines (Ahmed and Ali, 2006; Forsyth, 2005, 2006). In these two countries, EPR is used as a common means of implementation of development agendas, providing environmental infrastructure, and service provision where 'state funds or expertise are lacking' (Ahmed and Ali, 2006). Sri Lanka has enacted well-established legislation for environmental protection. The National Environment Act (NEA) was implemented to protect and manage the environment in 1981. The NEA has also arranged regulations to manage the WEEE. Table 1 presents some examples of WEEE legislation enforced by different countries.

3. Legislative responses to WEEE management in Malaysia

The increasing waste generation in Malaysia has forced the country to develop the environmental and waste management policies over a period of time. These policies are Environmental Quality Act (EQA) in 1974, the Action Plan for a Beautiful and Clean Malaysia (ABC) in 1988, the National Policy on the Environment (NPE) in 2002, the Environmental Quality (Scheduled Wastes) Regulations in 2005, the National Strategic Plan for Solid Waste Management (NSP) in 2005 (MHLG, 1998), the Master Plan on National Waste Minimization (MWM) in 2006 (MHLG, 2006a), the National Solid Waste Management Policy in 2006 (MHLG, 2006b), the Solid Waste and Public Cleansing Management Act (SWMA) in 2007 (GOM (Government of Malaysia), 2007), and finally extension to the Tenth Malaysian Plan in 2010 (EPU (Economic Planning Unit), 2005). The Environmental Quality Act 1974 (EQA) was formulated to prevent, abate, and control pollution, and subsequently improve environmental quality. The EQA empowers the Director General of the DOE to administer scheduled waste management for facilities, which generates, stores, transports, treats or disposes scheduled wastes. The Ministry of Housing and Local Government (MHLG) in 1998 initiated an Action Plan on Municipal Solid Waste Management, also known as an Action Plan for A Beautiful and Clean Malaysia (ABC). The objective of ABC was to produce a productive, environmentally sound, and socially acceptable municipal solid waste system in Malaysia by the year 2010. The national strategic plan for solid waste management (NSP) was formulated in 2002 and adopted in 2005 by the Government of Malaysia (GOM), and will provide the basis for SWM policies and measures in Peninsular Malaysia until 2020. The NSP suggested six strategies to guide solid waste legislative, institutional and infrastructural planning and management in Malaysia. The Action Plan developed the regulatory and technical services framework for improving solid waste management (SWM) and supporting infrastructural framework for a sustainable SWM system. The National Solid Waste Management Policy (NSWMP) was established to provide an integrated solid waste management system. The National Policy on the Environment (NPE) was formulated to continue economic, social, and cultural progress of Malaysia and enhance the quality of life of its people, through environmentally sound and sustainable development. The Solid Waste and Public Cleansing Management Act (SWMA) tried to manage the solid waste and public cleansing to support the maintenance of proper sanitation in Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. The SWMA includes the term 'controlled solid waste' to indicate the source of the waste and describes solid waste as scrap material or other unwanted surplus substance or rejected products produced

Table 1
The WEEE legislation in different country.

Country	Law/regulation/legislation	Date of enforcement	Responsibility
Switzerland	Ordinance on the Return, Taking back and Disposal of Electrical and Electronic Equipment (ORDEE)	July, 1998	Manufacturer Importer
Taiwan	Waste Disposal Act	1998	Producer (financial responsibility only, not physical responsibility)
Denmark	Statutory Order from the Ministry of Environment and Energy No. 1067	1999	Local Government
Belgium	Environmental Policy Agreements on the take-back obligation for waste from electrical and electronic equipment	2001	Manufacturer Importer
Japan	•Specified Home Appliances Recycling Law •Law for Promotion of Effective Utilization of Resources	Enacted 1998, enforced April 2001	Manufacturer •Retailer
Malaysia	Environmental Quality (Scheduled Wastes) Regulations 2005	2005	Manufacturer WEEE contractor
China	Administrative measures on the pollution of control caused by Electronic information products (Often referred as Chinese RoHS)	Adopted in 2006 and took effect 1 March 2007	Manufacturer
India	The Hazardous and Waste Management Rules	2008	Ministry of Environment and Forest (MOEF)

from the application of any process, but excludes scheduled wastes, sewage, and radioactive waste. The SWMA describes recycling as a process to collect and separate solid wastes for the purpose of producing products. The Tenth Malaysian plan (10 MP) is part of Malaysia's 5-year plans to inspire the national economy to attain economic growth and venture into infrastructure projects. The 10 MP is a complete proposal to distribute the national budget from the year 2011–2015 to all economic sectors in Malaysia.

4. Flow of used electrical and electronic equipment in Malaysia

WEEE is generally produced from the households and also from the business entities and organizations as whole unit of equipment or sub unit of functional equipment. These whole units of Waste Electrical and Electronic Equipment (WEEE) have been characterized as WEEE by the Department of Environment (DOE). In Malaysia, the Department of Environment (DOE) is under the Ministry of Natural Resources and Environment (NRE). The DOE, as permitted for in the Environmental Quality (Prescribed Premises) (Scheduled Waste Treatment and Disposal Facilities) Regulations 1989, has recognized a distinct group of contractors that are specifically licensed for the collection, transport, processing and disposal of WEEE. According to the information provided by the DOE Malaysia, there were 107 licensed contractors who are responsible to collect and process the WEEE. However, these licensed contractors only collect disassembled components or whole units of WEEE from manufacturers, and not whole units of WEEE from households or the business/institution sector. These whole units of equipment from the households are collected by the non-licensed private contractors if such units are not sent for repair. The licensed contractors collect the disassembled components such as plastic fittings, chipboards, metal parts, and cables from many electrical and electronic manufacturers. After the collection of these disassembled components, they send them to WEEE processor. The components manufacturers collect the processed components as their raw materials and the residues are disposed as the scheduled waste to the scheduled waste facilities. The non-licensed contractors or scrap collectors collect the whole unit of equipment from the households or business entities and institutions if these units are not sent for repair. After they collect the whole unit of components, they send it to scrap recyclers. At present, a regulated infrastructure is being enhanced for whole units of WEEE to be collected from households and business entities and institutions. Given the current high price of metals and plastics, the potential for the scrap collectors to profit from collecting and disposing WEEE for recycling is high. Fig. 2 presents the general flow of WEEE from the source of generation until the location of disposal identified in Malaysia. It indicates an important disconnect between the largest sources of WEEE and the DOE-licensed WEEE collectors and processors. The exception is a very small flow of used computers from business entities/institutions back to manufacturers who have recently practiced a take-back policy in exchange for new computers that are bought, as well as small volumes of used computers collected by the solid waste concessionaires in recent years.

5. Extended producer responsibility (EPR) and WEEE management in Malaysia

Malaysian policy and regulations started to consider EPR in the beginning of 1980s with the introduction of the Action Plan for a Beautiful and Clean Malaysia (ABC) in 1988 followed by the Environmental Quality Act (EQA) 1974 in 1996. But unfortunately, the National Strategic Plan for Solid Waste Management (NSP) in 2005, the Master Plan on National Waste Minimization (MWM) in 2006, and the National Solid Waste Management Policy (NSWMP) in 2006 did not widen the concept of EPR and originate complete strategies for a sustainable waste management system in Malaysia. On the other hand, Solid Waste and Public Cleansing Management Act (SWMA) in 2007 and the Tenth Malaysian Plan (10 MP) 2010, clearly integrated elements of EPR. From the observation it was found that only the EQA and SWMA have detailed requirements for EPR which comprises take-back systems, deposit refund system, and minimum recycled content, while policies such as the NPE, NSP, and MWM only mention EPR as a general concept on a voluntary basis, even though they are considered key policy documents for waste management in Malaysia. The development of environmental policies in Malaysia is ironic because the two key legislations for solid waste and scheduled waste management have already legally empowered the Department of Solid Waste Management (DWSM) and the DOE to implement EPR as early as the 1990s in Malaysia, but as of today both the DWSM and the DOE have not enacted supporting regulations to enforce EPR in Malaysia. This proves that the Malaysian policy-maker's focused on waste management on the basis of post-use collection, recovery, and disposal of both solid and scheduled wastes.

Voluntary initiatives of EPR in Malaysia are limited to a few multinational firms who have initiated EPR related activities such as take back programs (TBP), which are usually part of their global corporate environmental policies. Such companies include: Motorola, Nokia, Dell, Apple, and HP who have implemented voluntary recycling and take-back programs (TBP) which presents practical examples of EPR initiatives to the local Malaysian producers and industries. As such, Dell's branch in Malaysia introduces an online recycling facility and receives all brands of computer and computer peripherals for free recycling, and offers payment for customers who recycle unwanted Dell branded products (http://www.dell.com.my). The factor of customers' convenience is given consideration in this program and Dell provides free collection, upon receiving some information on contact and pick up details together with preferred collection date, which can all be done online. Other than Dell, two well-known mobile phones manufacturers, Nokia and Motorola, also adopted self-governance mode by providing disposal facilities for the users of their products. Nokia's recycling facilities called 'Nokia Kiosks' were initiated in 2001. 'Nokia Kiosks', however, are available only in three cities nationwide (Kuala Lumpur, Petaling Jaya, and Puchong) (www.nokia.com.my/nokiakiosk). The other mobile phone manufacturer, Motorola, provides recycling opportunity for the users of their mobile phones in a program called ECOMOTO Take-back (www.motorola.com). Information on the Motorola website states that there are seven collection points for customers to choose from.

6. The impact of improper WEEE on environment and health in Malaysia

The toxic elements in WEEE may be released into the environment in three ways. Firstly, due to improper disposal of WEEE, where WEEE is normally disposed with municipal solid waste and ends in non-hazardous landfill or is incinerated, and some are just dumped indiscriminately. In these instances, the toxic elements in WEEE may enter the soil and contaminate the groundwater, or enter the atmosphere as toxic fumes if burning is used as a way of disposal. In USA, it is estimated that 70% of mercury and cadmium pollution, and 40% of lead pollution in landfills are caused by leakage of WEEE (Puckett et al., 2002). Serious negative consequences on the environment and human health from WEEE recycling have happened in the past and still occur in China currently (Liu et al., 2006). Secondly, toxic substances are released into the environment through improper dismantling and precious material

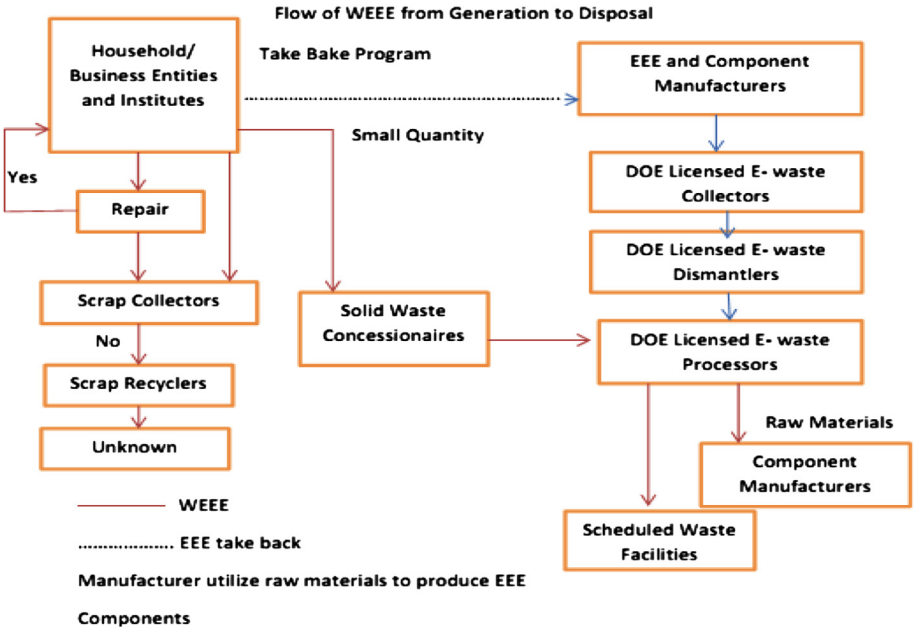

Fig. 2. Flow of WEEE from generation to disposal. Source: E-waste Inventory Project in Malaysia Report, 2009

recovery processes, where open burning and acid baths are used to recover precious material, which release toxic substances into the air, soil and water; while the less precious (but highly hazardous materials) are disposed of in an unsafe manner. WEEE recycling operations in more economically developed countries are carried out formally and initiated by a high level of awareness of environmental protection. WEEE recycling in less economically developed countries such as China (Eugster and Fu, 2004) and India (Sinha and Johri, 2008; Rochat et al., 2008; Streicher-Porte et al., 2005) is often carried out in the informal sectors, where extraction of copper, lead, gold, and silver are done crudely, (including manual dismantling of components, wet chemical processing such as immersing in sulfuric and nitric acid solutions, and incineration) (Sarkar and Johri, 2008), which poses significant environment and health hazards. In China, Qiu et al. (2005), Zhang (2009) argues that the negative health effects of workers in the WEEE recycling and recovery industry are higher compared to workers in other industries by these percentages; headache (47.7%), itch (15%), nausea (11.1%), insomnia (9.7%), hypomnesia (5.3%), and conjunctiva congestion (4.8%). In relation to WEEE recycling and material recovery activities, Malaysia faces the challenge of tracking down unlicensed/illegal operators, as many of them operate from backyards of houses or shop houses, normally in secluded areas, and often in the pretext of other legal business such as buying and selling of non-hazardous waste. These operators (mainly involved in partial recovery activities) conduct recycling and recovery activities of WEEE in an unsafe and unsound manner. In most of cases, it is conducted in very crowded areas in the Center of towns and favelas. Sometimes, the disassembling and recycling areas are without any appropriate lighting and ventilation. Computer parts and components are left lying around on the floor, posing the danger of accident to the workers. Tengku H.T.A.A (2011) found that out of date computers which were waiting to be processed were left in the open air, exposing it to leakage of hazardous substances to the soil and groundwater (Tengku-Hamzah and Adeline, 2011). In addition to this, his study showed that a huge amount of dismantled WEEE components were left under unprotected areas, which pose serious negative impacts on health and environment. Due to the lack of appropriate methods and substructures, the workers and laborers working are fronting serious work related and health risks (Empa, 2004). But luckily, there is no record to date of accidents related to environmental problems due to environmentally unsound process of recycling or material recovery of WEEE in Malaysia (E-waste Inventory Project in Malaysia Report, 2009). Though anecdotal accounts exist, including a report in the local newspaper suggesting that serious health risks are often experienced by workers, including severe skin damage from exposure to acids in a WEEE recycling facility (E-waste Inventory Project in Malaysia Report, 2009).

7. Methodology of the survey

7.1. Type of survey

We could use three methods in our study to conduct the survey, such as face-to-face interview, telephone interview, or mail (Yoo and Kwak, 2009). A telephone interview was the least chosen method because it can explain limited information. Mail surveys are seldom used because they provide extremely low response rates (Yoo and Chae, 2001). Of these methods, we chose to use face-to-face interviews with well-trained interviewers because they provide most complete, comprehensive, and meaningful high quality data (Creative Research Systems (CRS), 2010). In our study, the survey response rate was over 94%, which was much higher than what could be expected from a telephone interview or a mail survey.

7.2. Sampling methods

The total number of households in Kuala Lumpur is 286,325. In order to select a random sample of this population, the following sample size formulas were adopted in our research (Creative Research Systems (CRS), 2010):

$$ss^{'} = \frac{z^2(p(1-p))}{d^2} \quad (1)$$

where: z = z value (e.g 1.96 for 95% confidence level), p = percentage of respondents who selected a choice, expressed as decimal (0.5 used for the sample size needed), d = confidence interval or margin of error expressed as a decimal. The above

equation is appropriate for infinite sampling, but since the number of households is known in our study, the correction for a finite number of households is as follows.

$$ss = \frac{ss'}{1 + \frac{ss' - 1}{F}} \quad (2)$$

where, F = the number of households in Kuala Lumpur. Based on the sample size formulas, we selected $z = 1.96$, $p = 0.5$ and $d = 5\%$ and calculated the sample size which was 383. Due to limited resources such as money and manpower, we have selected 350 as our sample size. Total 350 questionnaires were disseminated among households through face to face interviews. Out of 350 questionnaires, only 20 questionnaires were unacceptable. According to Sekaran (2003), sample sizes larger than 30 and less than 500 are appropriate for most research. Leedy and Ormrod (2005) also believe that a sample size of 400 will be adequate if the target population size is beyond 5000. All the respondents were more than 18 years old. Before the final data gathering, we conducted a pilot test on 30 households to test the respondents' understanding, the clarity of the questions and to avoid any misunderstanding of the questions for this study. In September 2010, we conducted the final data gathering in Kuala Lumpur. In this study, Kuala Lumpur was chosen as the study area since the households of Kuala Lumpur are the instantaneous recipients of the waste collection system which is maintained by DBKL (Dewan Bandaraya Kuala Lumpur). DBKL is a local authority which administrates Kuala Lumpur city center and other areas in the Federal Territory of Kuala Lumpur. In this study, 70 households were selected randomly from each of the five urban areas in Kuala-Lumpur such as Selayang, Cheras, Ampang, Taman Jaya, and Kuala Lumpur.

7.3. Survey instrument and variables used in the study

In this study, different households were taken as our sample such as single storey terrace house, double storey terrace house, double storey, semidetached house, and bungalow. We selected household as our research unit. The first reason was two or more generations live together in one household to share expenditure and income (Qingbin et al., 2012). Another reason was that the household is the main source of WEEE generation in Kuala Lumpur. Song et al., 2012 also stated that EEE is considered as properties common to the household as a whole. The questionnaire used in our study had three parts. The first part asked the households about their knowledge and awareness about the impact of WEEE in health and environment. The second part gathered information about the household EEE product lifetime, the reasons for updating, and the deposit and disposal processes of WEEE. Finally, the last part asked the households that if the government improved the present situation of WEEE management, whether they were willing to pay or not. The variables which were used in our study were knowledge and awareness of the households about the impact of WEEE in health and environment, household EEE product lifetime, the reasons for updating, and the deposit and disposal processes of WEEE, and willingness to pay of the households for improving WEEE management system in Kuala Lumpur. The questions used in the questionnaire related to the specific objectives are shown in Appendix 1.

8. Results and discussions of the survey

8.1. Knowledge of the households about WEEE

The majority of the households (59%) knew that the electrical and electronic equipment could create problems in the environment as well as with human health. 41% of the households replied that they did not know about it. Other studies conducted in Malaysia revealed that the majority of the respondents had knowledge about the unsafe ingredients which existed in electronic products but only a few people ever recycled their wastes (Kalana, 2010; Gatke, 2003).

Table 2
Environmental elements considered during purchasing (%).

Items	Refrigerator	Air conditioner	TV set	Personal computer
Energy saving	56	98	72	65
Noise	18	61	62	52
Indoor air quality	23	65	10	7
Ozone depleting substances	19	17	24	43

8.2. Environmental awareness of the households about WEEE

Nowadays, people want to purchase new technological and environmental friendly products in order to protect their environment. People are more conscious when they purchase EEE for their households. In this study, the households were asked whether they considered the environmental factors when they purchased the EEE for their households. In response to this question, 65% of the households stated that they considered the environmental factors when they purchased EEE for their households. This means that the majority of the households have awareness about WEEE and its negative impact on the environment.

Table 2 presents the environmental elements considered by the households during their purchase of EEE. The results of the study show that a large number of the households gave their first priority to the environmental elements associated to saving energy in case of all EEE products, and consequently, attainment of some economic benefit, such as reducing electricity consumption. Furthermore, most of the households considered noise pollution in case of all EEE products, except the refrigerator. Indoor air quality was considered by the majority of the respondents only for air conditioner. Ozone depletion was given less priority by the households. This is due to the lack of knowledge of the households about ozone depletion. In a similar survey, carried out in Ningbo in 2003, the results indicated that the majority of the respondents gave priority to the environmental elements related to saving energy. The study also found that most respondents gave serious consideration to the environmental elements such as noise, indoor air quality, radiation because they were conscious about their own health and safety (Huang et al., 2006; Liu et al., 2009).

Table 3 reports the priority choice during purchasing of computer and refrigerator. The households stated that environmental labeled products, well-known brands, and cheaper prices were given priority by them when they purchased computers and refrigerators. In this study we found that the majority (73%) of the households mentioned that they had knowledge on environmental labeling products. In fact, the households chose environmentally friendly EEE because they considered their personal health safety. Other studies in China also found that the respondents gave higher priority to "famous brands and lower prices" while purchasing their household EEE (Huang et al., 2006; Liu et al., 2009).

Table 3
Priority choice for purchasing computer and refrigerator (%).

Items	Environmental labeled products	Lower price	Famous brand	Recommended by friends	Promoted by the store	Others
Personal computer	20	27	30	17	4	2
Refrigerator	28	27	36	2	3	4

Table 4
Updating time for electronic and electric products.

Television	%	Refrigerator	%	Washing machine	%	Computer	%	Mobile phone	%	Camera	%
1 to 2	1	1 to 2	0	1 to 2	0	1 to 2	2	1 to 2	37	1 to 2	0
2 to 4	25	2 to 4	3	2 to 4	1	2 to 4	40	2 to 4	48	2 to 4	6
4 to 6	35	4 to 6	24	4 to 6	25	4 to 6	38	4 to 6	11	4 to 6	19
Above 6	39	Above 6	73	Above 6	74	Above 6	20	Above 6	4	Above 6	75
Total	100	Total	100	Total	100	Total	100	Total	100	Total	100

8.3. WEEE management of the households

8.3.1. Updating time of the EEE product

Consumers are purchasing more EEE products due to rapid growth of electronic industries and changes in the consumer culture. As a result, it is increasing the rate of WEEE (Herat, 2007). However, the updating rate is associated with the designed lifetime of the product. According to commonly adopted international criteria, the product lifetimes are 8–10 years for color TVs, 13–16 years for refrigerators, 8–10 years for general air conditioners and 6 years for personal computers. Table 3 presents the updating time of the EEE used by the households. The results of this study present that most EEE used by the households are phased out within their product lifetime. Majority of the households said that their refrigerators and washing machines (73% and 74%, respectively) were phased out within 10 years. The households reported that much of their EEE was updated within two thirds of their designed lifetime, such as 62% of TV sets and 80% of computers.

8.3.2. Reasons for updating

Table 5 reports the reasons why the households updated their household EEE. The results of the study show that 24.55% of the households updated the EEE because new items had additional and more advanced technological features. Whereas, 22.12% of the households mentioned that the previous product was damaged or not functioning anymore and for this reason, they updated their EEE. Another reason which was reported by 11.21% of the households was the launching of new products with more powerful designs and extended capacity into the market. Increase in income of the households was also one of the reasons for updating EEE mentioned by a few households. Similar studies illustrated that the consumers normally updated their EEE products due to their desire to update and obtain new software, not due to breakage of the machine (Herat, 2007) and at the same time it is due to the decreasing lifespan of all consumer electronic products (Williams et al., 2008).

Table 5
Reasons for updating household electrical and electronic equipment.

Items	Frequency	Percentage
Previous product damaged or not functioning anymore	73	22.12
Not powerful/not enough capacity	37	11.21
New items have additional and more advance technological features	81	24.55
Increase in disposable income level	58	17.58
Influences by others (ex; through advertisement, friends and trend)	62	18.79
Other reasons	19	5.76
Total	330	100

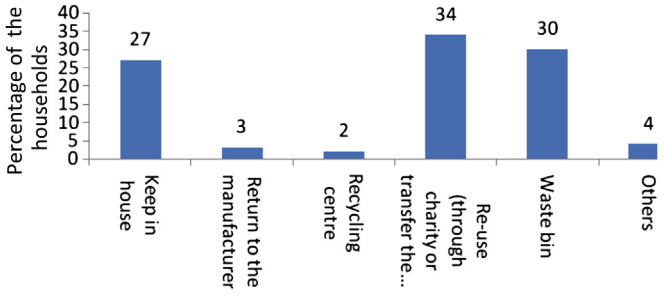

Fig. 3. Management of household WEEE.

8.3.3. Methods of disposal and deposit of EEE product

Fig. 3 shows the information about how the households managed their WEEE. When the electronic product became outdated and could not be repaired, 34% of the households mentioned that they re-used their electronic product, while 30% of the respondents mentioned that they threw them to the waste bins, and 27% of the respondents reported that they kept them in the house. It has been confirmed through literature review that maximum users stock their used or damaged EEE for couple of months until they can be resold or disposed (Williams, 2005). On the other hand, only between 2% and 3% of the respondents returned them to the manufacturer and recycling centers, respectively.

8.4. Willingness to pay of the households for improving WEEE management system in Kuala Lumpur

The households were asked that if the government built recycling infrastructure for household WEEE and improved the collection and disposal system of household WEEE, would they be willing to pay the associated recycling fee. It was found that only 52.5% of the households were willing to pay. The households who were not willing to pay were asked about the reasons. The majority of the households (51.72%) stated that they preferred to sell their WEEE to earn some money rather than pay the recycling fee. Whereas, 27.58% of the households lacked sufficient extra income to pay the recycling fee. Among them, 14.94% considered the fee as the responsibility of those people who are polluting the environment. A small percentage of the households did not believe in this kind of WEEE management projects and the rest of the households thought that it was not important. Other studies also found that the respondents considered their WEEE as valuable goods and would prefer to sell them to get some money back rather than to pay for the treatment of the waste (Kalana, 2010; Liu et al., 2009). However, the respondents were also willing to dispose their WEEE if they were provided with free services.

9. Conclusions and policy implementation

- Malaysia is facing great challenges in the management of WEEE which are domestically generated and imported illegally as 'used' goods. Another issue concerning WEEE in Malaysia is unacceptable disposal of WEEE and unlawful WEEE recycling. These activities have the possibility to contaminate the environment and create significant health risk for the society. The existing law in Malaysia on WEEE only controls and manages

the WEEE which is generated from industries. It does not have any provision to control and manage WEEE generated by the households. This is the weakness of the existing law. In this circumstance, ERP is found as a prospective way which can provide a suitable base for the formulation of new legislation to overcome the weakness of the existing law.

- However, the experience from other countries as mentioned in Section 6, may not be fully applicable in Malaysia, as most household waste generators are expecting payment for their waste (as they are aware of the precious content of WEEE), and are more inclined to value WEEE from the economic perspective rather than environmental perspective (Kalana, 2010). To implement the government-driven (mandated) and non-government driven (voluntary) EPR programs, there is urgent need to call for strong cooperation of government and non-government stakeholders.
- If the Malaysian government wants to implement effective policies based on EPR, it is essential to investigate the knowledge and level of awareness of the households, management of household WEEE, and willingness of the households to improve WEEE management systems. This study has found that the majority of the households (59%) had knowledge about the environmental and health impacts of WEEE. More than half of the households (65%) stated that they considered the environmental factors when they purchased EEE for their households. This means that the majority of the households had knowledge and awareness about WEEE and its harmful impacts on environment. But unfortunately it is found that despite their knowledge about WEEE, only between 3% and 2% of the households were involved with recycling their WEEE, such as returning their WEEE to the manufacturer and recycling centers, respectively. The reason may be currently in Kuala Lumpur, there is limited organized recycling mechanisms, such as Nokia's 'Nokia Kiosks' or Motorola's ECOMOTO which take back from the customers to recycle their WEEE. So, the government can take the initiative to build the appropriate infrastructure for recycling facilities and implement EPR with the cooperation of nongovernment stakeholders.
- In this study, it has been found that most EEE used by the households is phased out within their product lifetime. It has been observed that recently innovations in televisions and mobile phones is contributing large number of outdated machines in short periods of time (Babu et al., 2007) and subsequently increasing the amount of WEEE in the world. In USA, for example, the lifespan of computers was four to six years in 1997, but by 2005 it had been drastically reduced to less than two years (BAN/SVTC, 2002). One study suggests that the driving force behind WEEE production is the rapid growth of computers and computing systems (Anderl and Freudenschuss, 2006)
- It has been also found in this study that 52.5% of the households were willing to pay for improving WEEE management in Kuala Lumpur. It is assumed that the households preferred to sell their WEEE to the scrap collectors rather than pay for someone to collect the waste. The government in Malaysia can organize campaigns, workshop, and seminars to increase the level of awareness of the households and to motivate them to recycle their WEEE.
- However, the environmental impact of WEEE recycling and material recovery management option is low compared to that of disposal (through landfill or incinerator) management option (Robinson, 2009). In these circumstances, the scrap collector and recyclers are doing recycling in an unsafe environment; therefore, the government in Malaysia can take initiative to transfer of appropriate technology to manage their WEEE keeping in mind the safety of these collector and recyclers. If possible, they can try to redesign their own EPR policy based on their capacity to execute such policy. Whichever policy is implemented, management of WEEE is a great challenge to Malaysia with their limitations and challenges. Therefore, serious consideration should be given to a regional policy framework, where economies of scale may be more suitable.
- A key policy implication of the results of this study is that policymakers will be informed about the knowledge, awareness, and WTP of the households to improve the WEEE management system in Kuala Lumpur, which will be helpful for them to design an improved WEEE management project for Kuala Lumpur. Without knowing the costs of providing various service improvements, we cannot recommend specific improvement measures. What we can state with clarity, nonetheless, is that survey respondents state a clear preference for improvements in waste management services and a considerable WTP for it.

Appendix 1

Objective	Question	Type of answer
To investigate the knowledge of the households about WEEE	Do you know that electrical and electronic equipment has caused problems in your health and the environment	a)Yes b)No
To investigate the awareness of the households about WEEE	When you buy the electrical and electronic equipment did you consider the environmental elements?	a)Yes b)No
	If you consider the environmental elements when you buy the electrical and electronic equipment, which of the environmental elements did you consider during purchasing?	Please see Table 2
	When you purchase personal computer and refrigerator, which is priority choice for purchasing that product?	Please see Table 3
To investigate how the households manage their WEEE	Please mention the updating time for your electronic and electric products?	Please see Table 4
	Why did you update or buy new electric and electronic product?	Please see Table 5
	If any electronic product becomes obsolete and cannot be repaired, what do you do with it?	Please see Fig. 3
To investigate the willingness to pay of the households for improving WEEE management system in Kuala Lumpur	Currently all of the WEEE recovery facilities in Malaysia are built and operated by private companies. The industry or WEEE generators send their WEEE to these WEEE facilities or department of environment. The government is planning to implement a project on how to effectively collect the WEEE from the residential areas. If the government improves the WEEE management system in Kuala Lumpur, are you willing to pay the recycling fee?	a)Yes b)No

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