Development of a Web Based Electronic Waste Management System:
A Study with Special Reference to Recycling Companies in Sri Lanka

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Abstract: Information and Communication technology (ICT) and/or Information Technology (IT) are the effective tools that have been employed in the field of education, research, administration and other ways for the betterment of the human life that brings revolution in the modern era. There are number of advantages and disadvantages available in using ICT for our activities. One of the major disadvantages of ICT and its devices is harmful substances including carbon dioxide (CO2) to the environment that are not eco-friendly. Software and hardware part of IT has touched most of the parts of social, technical, economic and natural environment. Exponentially increasing production of computer hardware has posed major challenges of proper disposal of the electronic waste (e-waste) produced by this industry. Recycling companies are the key stakeholders in managing e-wastes in developing countries. But, they don't have any proper system to handle those wastes. Therefore the objective of this research is to explore and investigate the current condition of electronic waste's recycling system in Sri Lanka and to study the problems faced by recycling companies in handling e-wastes as well as to develop a use case diagram to build a computerized system to solve e-waste recycling problems. A web based system, based on the use case diagram will be developed as the recycling companies of Sri Lanka and can put into operation that may be adopted for sustainable management of e-waste. The research method is case study and it is comprised of two phases: analysis the problem definition and develop a system design as a use case diagram. A structured questionnaire and informal interview methods were used to collect data. Secondary data from sources such previous research article on published and unpublished journals, websites, company database information, annual reports, magazines, etc were used. The population of the research was recycling companies of Sri Lanka and the sample size was seven registered recycling companies. The final system will be helpful for e-waste recycling companies to manage e-wastes and it will be benefited to the community and the nation as well.

Keywords: Electronic waste, Recycling, Information Technology and Sustainable development

I. INTRODUCTION

Information and Communication technology (ICT) and/or Information Technology (IT) are the effective tools that have been employed in the field of education, research, administration and other ways for the betterment of the human life that brings revolution in the modern era. It creates numerous benefits including sustainable development by reducing environmental impacts replacing physical activities into virtual [Malik 2012]. There are number of advantages and disadvantages available in using ICT for our activities. One of the major disadvantages of ICT and its devices is harmful substances including carbon dioxide (CO2) to the environment that are not eco-friendly [Malik, 2012]. So, the concept of green computing was emerging with the purpose of environmental protection from ICT infrastructures.

Electronic Waste is commonly known as "e-waste", it refers to various types of waste electrical and electronic products. It can be divided into seven classes which are listed as computer products, communication products, audio-visual products, radio and television equipments, household and similar electrical appliances, instruments and measuring and monitoring products, electric tools, and wire and cable. And all the parts, components and materials that make up these products, those waste products and imperfections generated in the production process and defective products, etc.

With the rapid development of electronic industry, the continuous upgrading of electronic products lead to the elimination of more and more waste electronic products and electrical equipment around the world which would result in the formation of a large amount of electronic waste. Electronic waste has become the fastest growing garbage in the world. Most developed countries have begun to pay attention on the electronic waste recycling and disposal long time ago, and respectively established a suitable system of electronic waste recycling.

Electrical and Electronics Equipment (EEE) have generally made life easy and convenient because of their efficiency and time saving in application. Communication systems, as they

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are today, would not have been achievable without electronics technology. Entertainment industry (music, radio, television, cameras, etc.) would have remained crude if not for continuing development in electronic technology. Household equipment, now making use of electricity and electronics, are making domestic chores (washing, cleaning, cooling, heating, etc.) continuously easier and more convenient.

Sri Lankan electronics and IT industry has grown very fast and it not only resulted in more consumption of raw materials but also in problems due to waste generated and e-waste is one of them [Cairns, C.N. (2005)]. E-waste stands for electronic waste, which is a branch of Waste Electrical and Electronic Equipment (WEEE).

Growing of economics and expanding of country and manufacture industry in recent years including the significant competition in the market which leads to continually develop of technologies rapidly. In order to need of new electronic products of consumers in the market, worse in quality and shorter life for many electric appliances would be happened as Electronic Waste or e-Waste.

II. PROBLEM STATEMENT

For sustainable management of e-waste, a country has to develop such a flexible and adaptive system that can handle the variability in quantity and quality of e-waste flow [Sinha-Khetriwal, D., Kraeuchi, P. and Schawninger, M. (2005)]. The best available practices from different countries can be adopted to manage e-waste effectively [Wath, S.B., Dutt, P.S. and Chakrabarti, T. (2010)].

Despite these initiatives, Sri Lanka is still far away in terms of e-waste management compared to most countries. Thus, existing bottlenecks need to be addressed in order for Sri Lanka to be a sustainable e-waste recycler. Strengthening policy and legislation is vital. Apart from the existing policy and regulation, the government could reinforce regulations, specifically on the imports of EEE. For instance, regulations should be enacted on discouraging the imports of used EEE, and to import equipment that has less hazardous elements; for example, LED/LCD monitors can replace CRT monitors, since CRT has more hazardous elements. In addition, suitable technology and skills need to be implemented in order to streamline the sustainable e-waste recycling system in the country. Proper mechanisms should also be developed to take out the informal market for e-waste recycling in the country. Improving the knowledge on e-waste within the community is crucial. Conducting programmes which highlight the social and ecological impacts of improper handling of e-waste, and the importance of disposing e-waste in proper places and in proper ways can be effective in raising public awareness. This can be provided through the public health staff, starting from grassroots levels. Also, the media can play a pivotal role in disseminating the message and making the mass community aware of the impacts of improper handling of e-waste as well as the proper mechanisms in recycling and its benefits.

III. RESEARCH OBJECTIVES

To explore and investigate the current condition of electronic waste's recycling system in Sri Lanka and to study the problems faced by recycling companies in handling e-wastes as well as to develop a computerized system to solve e-waste recycling problems. A web based system, based on the research will be developed as the recycling companies of Sri Lanka can put into operation that may be adopted for sustainable management of e-waste.

IV. METHODOLOGY

Research designing is a significant phase to examine the relevant situation. The research design and choice of the research design was directed by the purpose of the study, research model, nature of the data and other backgrounds of the study etc. (Mitchell and Jolley, 2010).

This research is comprised of two phases: analysis and problem definition and to draft a prototype system design.

Phase 1

This phase begins with a literature review of issues affecting e-waste management process in Sri Lanka. The literature review then focuses on Web based technologies and its application in the e-waste and managing tactics. Based on the preliminary literature review, the need for a Web based system is determined. The system architecture and the way in which they work are studied in depth, to provide the foundation for the development and implementation of the prototype system.

Phase 2

Data collection starts with various e-waste organizations. Survey method will be used to collect data with structured questionnaire and formal interviews. Secondary data will be obtained from local websites, books, research papers and newspaper articles related to e-waste management practices in both global and Sri Lankan context. After data collection, a use case diagram will be then designed and populated.

The population and Sample

The sample size will be selected in a way that to be conducted and also to be representative of the population. The researcher decided to conduct 07 registered recycling companies of Sri Lanka. The sample size is limited due to the cost, time constraints and population size. The sample size details are given below,

   I.   Geocycle, Holcim (Lanka) Limited
  II.   Green Link (Pvt) Ltd
 III.   Z Max Enterprises

IV.   Asia Recycling (Pvt) Ltd
V.   Ceylon Waste management (Pvt) Ltd
VI.   Think Green (Pvt) Ltd
VII.   J F Supplier

Data collection methods

A structured questionnaire and formal interview methods will be used to collect data and questionnaire will be pretested before the final administering. Secondary data from sources such previous research article on published and unpublished journals, websites, company database information, annual reports, magazines, etc will be used.

V. FINDINGS

Sri Lanka as a rapidly developing country imports large amounts of electronic items a year. But only a little concern is paid on what happens to the obsolete or damaged equipment which are no longer in usable state.

Bellow table shows the annual imports of major types of electronic and electrical items in Sri Lanka (according to 2010 statistics of Sri Lanka Customs), their average useful life times and the forecasted growth rate in next couple of years. These details are only of the items, which are legally imported to the country. In the practical scenario, these figures could be larger than this. With these figures, we can get an idea about the amount of e-waste generated in one year.

Sri Lanka is to implement a countrywide "Electronic Waste Management" project with the active participation of the private sector electrical and electronic equipment companies.

The Central Environmental Authority (CEA) will sign a Memorandum of Understanding (MOU) with 14 companies on May 26 2014 to properly and effectively manage Waste Electrical and Electronic Equipment (WEEE).

The partner companies comprises telecommunications industry (SLT, Mobitel, Dialog, Etisalat, Hutch and Lanka Bell), home appliances (Singer and Abans), office appliances (Metropolitan, E-Wis, Virtusa, and ABC Trade & Investments), and service providers (Geo Cycle and Green Link, Recycling Pvt Ltd Ceylon Waste Mnagement Ltd, Think Green Pvt Ltd, Green Cycle and Holcim (Lanka) Ltd.)

These service providers are exporting e-waste to countries like Korea as Sri Lanka has no proper e-waste recycling facilities, he revealed. A large number of unusable mobile phones and their accessories, discarded TVs, radios and their accessories and other consumer goods such as refrigerators, ovens, washing machines and bulbs is stockpiled in homes and offices as there is no proper disposal system and lack of awareness on WEEE disposal among the people, he said.

As an initial step, the CEA has declared an electronic waste management week with the aim of eliminating the e-waste problem countrywide. Consumers have been given an opportunity to hand over their e-waste to partner companies on the directions of the CEA.

The districts of Colombo, Nuwara Eliya, Anuradhapura and Polonnaruwa have been identified as the ones where most polythene and plastics waste is generated. That is because a number of religious and other festivals take place in these areas, drawing large crowds of people. According to a ministry of forestry and environment survey, 185 tones of non-degradable polythene and plastic waste are thrown out within the Colombo district each day. To process larger volumes of waste a big washing plant is needed. That what we provide from Think Green, the services to recycle your wastage.

According to the data collections, the e-waste management activities of Sri Lanka can be limited into three activities.

[1] Recycling: - Recycling is the practice of reusing items that would otherwise be discarded as waste. e-waste recycling is the disassembly and separation of components and raw materials of waste electronics. Although the procedures of re-use, donation and repair are not strictly recycling, they are other common sustainable ways to dispose of IT waste. This activity can be sub categorized into four actions.
   o Reuse items - the items that can reuse after minimal repair
   o Recover items - the items that can be recover after some effort
   o Reduce items - some of the item parts can be reused
   o Recycle items - whole item need to be recycled

[2] Reselling: - All items brought into the collection center are tested and evaluated to either be recycled or resold. Those items eligible to be resold are marked with clear notes and marked with a fair price.

[3] Disposal: - When batteries, thermostats, electronics, oil, and other potentially hazardous wastes are improperly disposed of, they can harm public health and the environment. Batteries and e-waste such as computers, printers, and cell phones contain toxic heavy metals such as lead, mercury, and cadmium. When they are thrown away in the trash, they end up in landfills, and these toxic compounds can leach into soil and water, polluting lakes and streams and making them unfit for drinking, swimming, fishing, and supporting wildlife. In addition to making sure these wastes are disposed of correctly.

VI. RECOMMENDATIONS

According to the research, the activities and the analysis of the recycling process are explained below,

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Firstly the customer (a single user, group of people or a company) inform about an e-waste stock. Then the company sends a vehicle (e-waste collector) to collect and pay them. After the company receives the stock, they need to categorize it to the four actions of recycling as,

1). Reuse items
2). Recover items
3). Reduce items
4). Recycle items

So employees will categorize the e-waste stock into these 4 categories. Operator needs to update the relevant stocks separately. Recycle items need to be passed for recycling. After recycling they are getting the raw materials. Then they can have to contact with buyers to resell these items. Buyers must be registered within the system. Reuse and Recover items will earn them more money. Reduce items will sell as spare parts. Recycling items will sell as raw materials.

The model of use case diagram is given in the figure 1.1. The recycling companies can use this diagram to develop a system to run their operations effectively which may useful for the sustainable development of information technology.
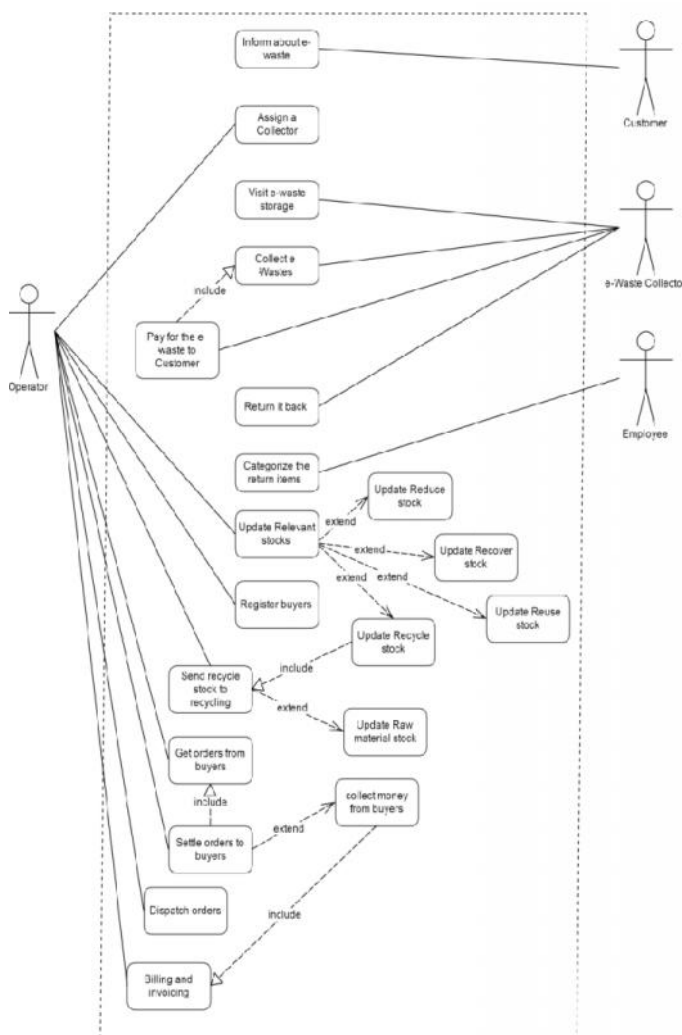

Figure 1.1:- Proposed use case diagram

VII. CONCLUSIONS

E-waste is a popular informal name for electronic products nearing the end of their useful life. Anything that runs on electricity/battery or has wire and completed its life is e-waste [Freemn, USA, 1989]. Electronic waste may be defined as discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators. E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. According to European Union (EU 2002), e-waste is, "Electrical or electronic equipment, which is waste, including all components, subassemblies and consumables, which are part of the product at the time of discarding."

Recycling facilities exist in developed countries and stringent measures have been taken by the Governments regarding disposal of e-waste. However, there are difficulties in implementing regulations and dealing with e-waste owing to increased activism by environmentalists and the high cost of recycling. Despite concerns on the issues of fraudulent traders and environmentally unsound practices, it has been easier and cheaper for these countries to ship e-wastes to the developing countries where access to and recycling of such discarded electronic goods make a good economic option. For both sides, it is profitable or a win-win situation. The only difference being that the rich country is dumping toxic waste on the poorer country.

As there is no separate collection of e-waste in Sri Lanka, there is no clear data on the quantity Generated and disposed of each year and the resulting extent of environmental risk. The preferred practice to get rid of obsolete electronic items in India is to get them in exchange from retailers when purchasing a new item. People in developing countries usually go for low priced electric and electronic equipments due to the unavailability of financial resources. Most of demands in these equipment markets are being quenched by the importation of used equipments from developed countries.

Ground level research and studies have now been completed to venture into e-waste recycling. Hazardous types of material used in electrical equipment are dangerous to be stored at offices or homes due to the harmful effects on humans and the environment. Anyway In Sri Lanka the Hazardous Waste (Scheduled Waste) Management rules were first announced under the National Environmental Act in 2008 under the Gazette Extraordinary 1534/18. As per this regulation E – Waste has been categorized as a scheduled waste and every generator, collector, storer, transporter, recover, recycler and disposer should obtain a license from the CEA.

It is essential that every citizen should understand that E –Waste is hazardous and it is their responsibility to get it managed in an environmentally sound manner. The CEA has mandated that the E – Waste should be given only to

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authorized collectors. There are fourteen licensed collectors have been announced by CEA in their special notice.

To solve the above issues, it is found that a computerized web based system can be helpful for sustainable development and zero or minimal impact to the environment by the technology devices.

After carefully researching the issues with recycling companies of Sri Lanka, a solution framework is developed as a use case diagram to develop a web based system to handle number of e-wastes effectively.

The proposed solution can be implemented by any recycling companies with necessary modifications based on their business functions.

Further, the study should be extended to mobile platform and global positioning system (GPS) to recycle the e-wastes quickly. However the time and budget constraints, this study is limited to a web based system development platform which is a big need for recyclers to shape their functions easily.

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