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Developing an Integrated Electronic Waste Management Approach in Malaysia

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Abstract –*Production of electronic products is one of the world's developing industries at present. In line with this phenomenon, the accumulated electronic waste has increased as a result of increase production of electronic product. Knowledge on electronic waste compositions, contamination compounds in wastes, law, guidelines and methods of the management is essential in order to form a cost-effective and an environmental friendly management system. The aim of this study is to propose a technique to manage the electronic wastes in integrated and holistic manner. The result of this study is obtained from the observation, interview and model development. The studies propose the use of Life Cycle Assessment to predict the burden and impacts of the integrated electronic waste management system towards surroundings. The finding of the study propose that the implementation of an integrated electronic waste management has to combine sustainable technique for waste collection, waste sorting, materials recycling, thermal treatment and landfill methods in order to achieve maximum effectiveness of the system. However, the pollution control facilities are necessarily important to be part of the sustainable technique to ensure that the system will produce the best management method for electronic waste. The advantages of implementing integrated electronic waste management are this system able to contribute to the economic increase of a country and reduce the impacts of pollutants to the environment.*

Keywords: Integrated, Life Cycle Assessment, Pollution Control, Environment

1.0 INTRODUCTION

World's rapid production of electronic products has contributed to the increase of electronic wastes accumulation. Technological changes, short life span and production of various electronic products in the market have caused frequent modifications from one electronic product to another [1]. As a result from this scenario, there is an increase in the accumulation of solid wastes from the electronic products sources. Study conducted by Perunding Good Earth (2008) stated that in Malaysia, about 761,507 million unit of electronic waste for six categories i.e television set, refrigerator, mobile phone, personal computer, air-conditioners and washing machine will be generated from the year of 2008 until year 2020 [2].

Electronic waste (E-waste or WEEE) is the acronym for the various forms of electrical and electronic wastes that have lost their values to the users. Eu Directive has defined an electronic waste as an entity or an object to be disposed by users or required to be disposed under the national jurisdiction. The Basel Action Network has stated that an electronic waste

encompasses the range of growth of household electronic inventions such as refrigerators, air-conditioners, telephones, personal stereos and computers discarded by consumers [3].

Knowledge related to solid electronic waste composition is important to build a cost-effective and an environmental-friendly management system. On the whole, a solid electronic waste is complex and non-homogeneous in term of materials and components. Although the materials and components are from recycled materials, at the same time they are able to pollute the environment if the wastes are not properly managed. Most of the studies conducted by some researchers classified electronic wastes are formed from five materials namely plastics, metals (with iron or without iron), glasses (with plumbum or without plumbum), wood and others. Electronic wastes contain high toxic compounds that are able to pollute the environment [4]. The toxic constituents are heavy metal (cadmium, lead, chromium, mercury, plumbum, arsenic, selenium, etc.), precious metals like silver, gold, copper and platinum [5] and organic chemical compounds i.e. flame retardant including plastic resins Polyvinyl Chlorine [1]. Toxic constituents produced from electronic wastes in the form of liquid will pollute the water and those in the form of gasses will pollute the air.

Electronic waste management has become a global issue prevalent in either developing or advanced countries. Difference in technology and experts factors lead to difference in methods of waste management. However, studies on management methods and technological applications subscribed by other countries can be set as guidelines to select suitable techniques for local adaptation.

For European countries and countries like Austria, Germany, French and Belgium, the accepted and applied practices to manage and dispose electronic wastes is the encouragement for the usage of environmental-friendly designs for electronic products manufacturing. For the electronic products producers, they are to be responsible for their electronic waste management. This concept is known as Extended Producer Response (EPR). All electronic products in the market have to be free from toxic compounds such as plumbum, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl [6]

In the United States of America, the accepted practices are by giving a tax exemption for users who buy environmental-friendly electronic products, by implementing EPR concept based waste management and by prohibiting the disposal of cathode ray tubes at disposal sites [6]. In the Republic of China, the accepted practices are the reusing of electronic wastes as raw materials, the prohibition of bringing in electronic wastes into the country, the electronic waste management process must abide the laws on preventing solid wastes from polluting the environment, the approach on EPR concept and the strict security on hazardous compounds management [7].

In Malaysia, the waste management strategies in the past focused more on the waste management system based on the hierarchical concept. In short, the hierarchical system suggests a disposal technology based on priority starting with the reduction technology, reusing, recycling, composting, incinerating to produce energy, incinerating without producing energy and the final technology is the ground burial technology [8]. However, the management based on the hierarchical concept has some weaknesses due to the non-existence of a management technology that is able to produce optimal management effects. An effective waste management concept has to combine two or more management selections to minimize the cost and maximize the benefits to the society [9]. Hence, the guiding principles behind the solid waste management practice in Malaysia have to be revolutionised without delay.

Fundamentally, the operation between a management systems is related for the waste management technique that implement integrated waste management concept. Applied collecting and segregation system has an effect in regaining material resources or in producing compost materials with market potentials. The mentioned aspect has indirectly affected the possibility to derive energy from wastes. However, recycling, composting and thermal treatment will leave residues to be disposed at disposal sites. Therefore, the whole system is made clear through a holistic approach.

This integrated approach will reduce disposal sites' burden and open an opportunity for a new technology to manage solid wastes [8]. The eco-effective solution will generate an optimal balance between the environment and economic cost impacts from the initial production to disposal [9]. To implement the above-mentioned proposal, the authorities have to acquire a comprehensive central data of the accumulated solid waste quality and quantity in Malaysia [10]. The central data has to encompass solid waste composition analyses such as the vicinity analysis, the final analysis and also the analysis to identify waste calorie values acted as fuel energy. This data is helpful in designing modified solid waste plants [11].

If electronic wastes are disposed or recycled without a proper supervision, its impacts towards the environment and human health are predictable. For the recent 20 years, the government and the society aspire to manifest an evolution towards the industrial system by measuring the environmental impacts exist due to industrialisation activities. The objective is achievable if the life cycle assessment technique is brought forth in devising a policy or designing a system [12]. For that reason, this paper is to introduce the integrated concept for managing electronic waste. To achieve sustainable management concept, conducting life cycle assessment of the integrated system for electronic waste management is essential in order to predict the environment and economic impact of the system.

2.0 METHODOLOGY

Electronic waste management flows is obtained through the observation and interview with the local authority, local resident, commercial sector, environmental group and solid waste management company.

The model development for integrated system to manage electronic waste is obtained through the observation of the existing local infrastructure facilities for managing the solid waste and through the life cycle assessment concept. The life cycle assessment concept includes an analysis of a product or a system from the beginning until the end (cradle to grave) that is by analysing the environmental impacts and methods to regain energy resources. In this study, local infrastructure facilities include observation of the waste collection facilities, recycling facilities, thermal treatment facilities, landfill facilities and pollution control facilities for managing the electronic waste.

3.0 RESULTS AND DISCUSSION

Figure 1 and Figure 2 shows the current practice of the electronic waste management at residential, commercial and industrial area. The current electronic waste management practice by the environment group is shown in Fig. 3. Figure 4 shows the model development for integrated electronic waste management concept based on the life cycle assessment technique.

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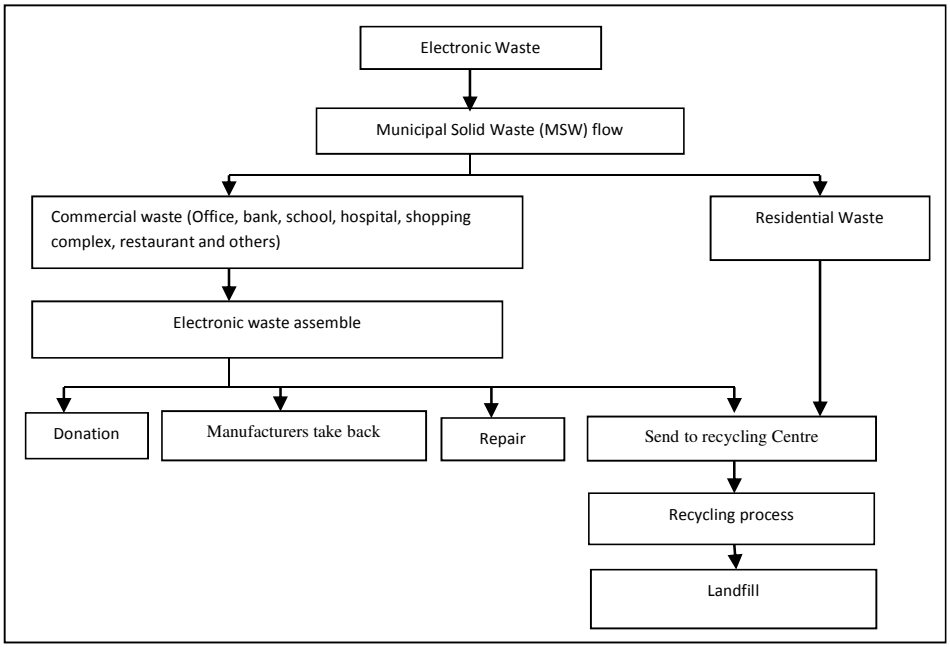

Figure 1: Current practice of E-waste management at residential and commercial area

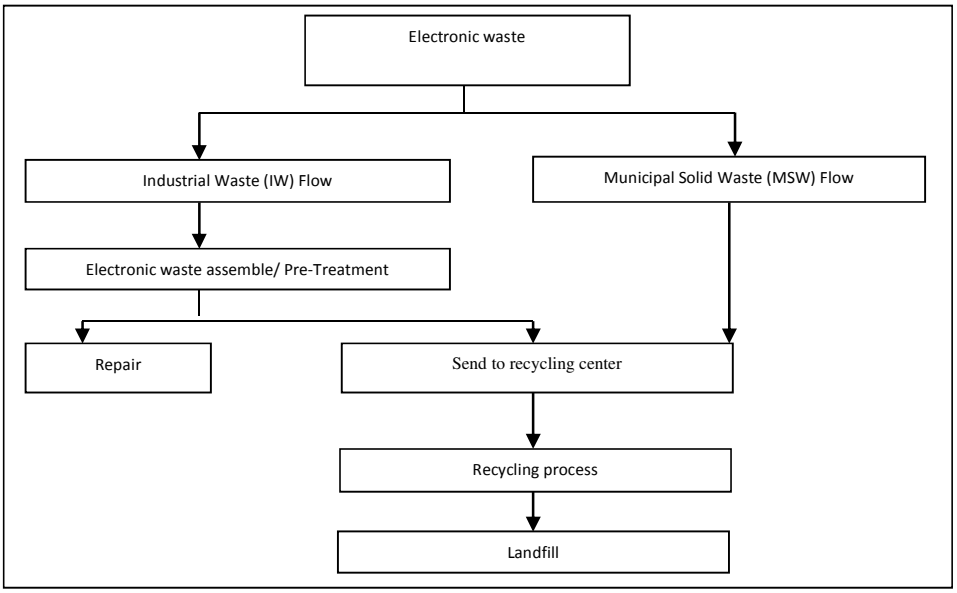

Figure 2: Current practice of E-waste management at industrial area

In reference to Fig. 1 and Fig. 2, the practiced methods in the electronic waste management are the methods of reusing, recycling and disposing. Reusing method includes the concept of donation such as to donate an electronic product by one user to another, the reclamation of

electronic products to be processed by industrial proprietors and for users to refurbish the electronic waste components. For recycling method, materials from electronic wastes such as plastics, metals and other valuable components will be gathered at the recycling centres. All those materials will be processed to produce secondary raw materials and then to be sold to local or foreign industrial proprietors for them to generate certain products. Disposing method that practices ground burial technology will permanently exterminate the worthless electronic wastes.

Refer to Fig. 1 and 2, the source for electronic wastes originates from housing areas, commercial buildings and industrial sectors. In Malaysia, there are two major flows of electronic wastes i.e. Municipal Solid Waste (MSW) Flow and also through Industrial Waste (IW) Flow. Normally, bulk electronic wastes will flow through MSW flow whereas electronic wastes from industrial disposals will flow through IW flow. Electronic waste management will undergo the process of gathering, collecting, re-using, recycling and finally, disposing.

From the aspect of solid waste management, electronic wastes include the production of solid wastes such as plastics, metals, woods, etc. accumulated during the process of making such electronic products. Therefore, according to the minor jurisdiction as outlined by the Ministry of Housing and Local Government in Malaysia, solid wastes generated from industrial activities are classified as industrial solid wastes [13]. To be concise, an electronic waste is referred as bulk electronic waste and also industrial solid waste. Bulk electronic waste includes television, audio and stereo equipment, telephone, facsimiles, cellular phones, computers, printers, vacuum cleaner, refrigerator, washing machine, lamp, fan and others. Industrial solid waste includes plastic, metal, glass and wood that generated from electronic manufacturing factories.

In Malaysia, there are some industries and organizations that have already performed the activities of recycling electronic wastes. The Industries processes electronic wastes consisting metal (ferrous, non-ferrous and others) into scrapes and then they are sold to factories as secondary raw materials. The Environment groups conduct electronic materials recycling programmes for the locals and then they establish community recycling teams. The function of these groups is to collect and buy electronic wastes from the locals and then to sell them to recycling agents. Electronic waste buyers will then purchase these wastes from the agents and sort them according to types such as computers, washing machine and others. Then, the wastes will be sent to the processer industries to be processed (dismantling, segregation and crushing wastes). The processed waste materials will finally be sold to products manufacturers. The resulting residuals will be disposed at the secured landfill site [14]. The flowchart in Figure 3 shows in brief the electronic waste management practice by the environment group.

Solid waste management by the local authorities in Malaysia encompasses some processes before the solid wastes are able to be disposed at the waste disposal sites. As the other developing countries, solid waste management in Malaysia will undergo the processes of production, storage, collection, recycling, recovery and disposing. However, there are some arising issues and problems in performing the solid waste management operation. The problems with waste management techniques in Malaysia can be elaborated into several factors namely disintegrated management system, unsuitable usage of technology, lack of experts, lack of infrastructures for each management option, lack of data and information, lack of system of law and enforcement, and lack of studies towards the health and environmental impacts related to each waste management option [9]. For that reason, Malaysian is in the process of prioritized green technology application to manage solid waste in future [15].

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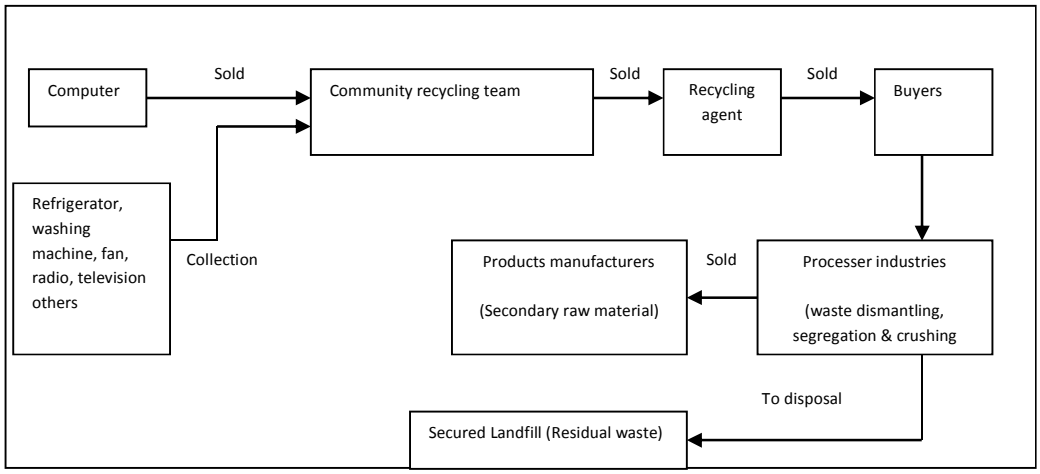

Figure 3 The E-waste management practice by the environment group

For developing an integrated electronic waste management approach, integrated system has to combine waste collection, waste sorting, materials recycling, thermal treatment, and ground burial disposal and pollution control methods. The combination of management selection plays an important role in ensuring the maximum effectiveness of the integrated waste management system. Basically, the aim of developing integrated electronic waste management is to offer maximum benefits to the environment, to optimise the economy as well as to be accepted by the society. Hence, integrated approach managing electronic wastes from the point of accumulation to the point of disposal.

The lifecycle assessment technique can be used to predict the burden and impacts towards surroundings from the beginning until the end of the management system. Figure 4 shows the waste management model when any entity or object loses its value and converts into waste and again reforms into valuable materials such as secondary raw materials or energy, waste residues, or as contamination compounds released to the environment.

Refer to figure 4, the pollution control resulting from the waste management activities can be divided into three namely air pollution control, water pollution control and residual disposal control. The air pollution control system acts as pollutant eliminators in gasses before they are released into air. A waste water treatment plant acts as a water pollution control system for waste water resulted from managing waste activities such as leachate and washing wastewater. As for the control of residual disposals at disposal sites, it is done by disposing the residuals at sanitary disposal sites for non-hazardous residuals while the hazardous residuals will have to be initially modified before disposing them at secured landfill sites. An economic increase and environmental sustainable is achievable based on the reduction of the amount of energy usage (electricity, gas, diesel or petrol), the re-using of wastes as secondary raw materials, the reproduction of energy from wastes, the reduction of the waste total volumes at the disposal sites and the reduction of the pollutants emissions to the environment.

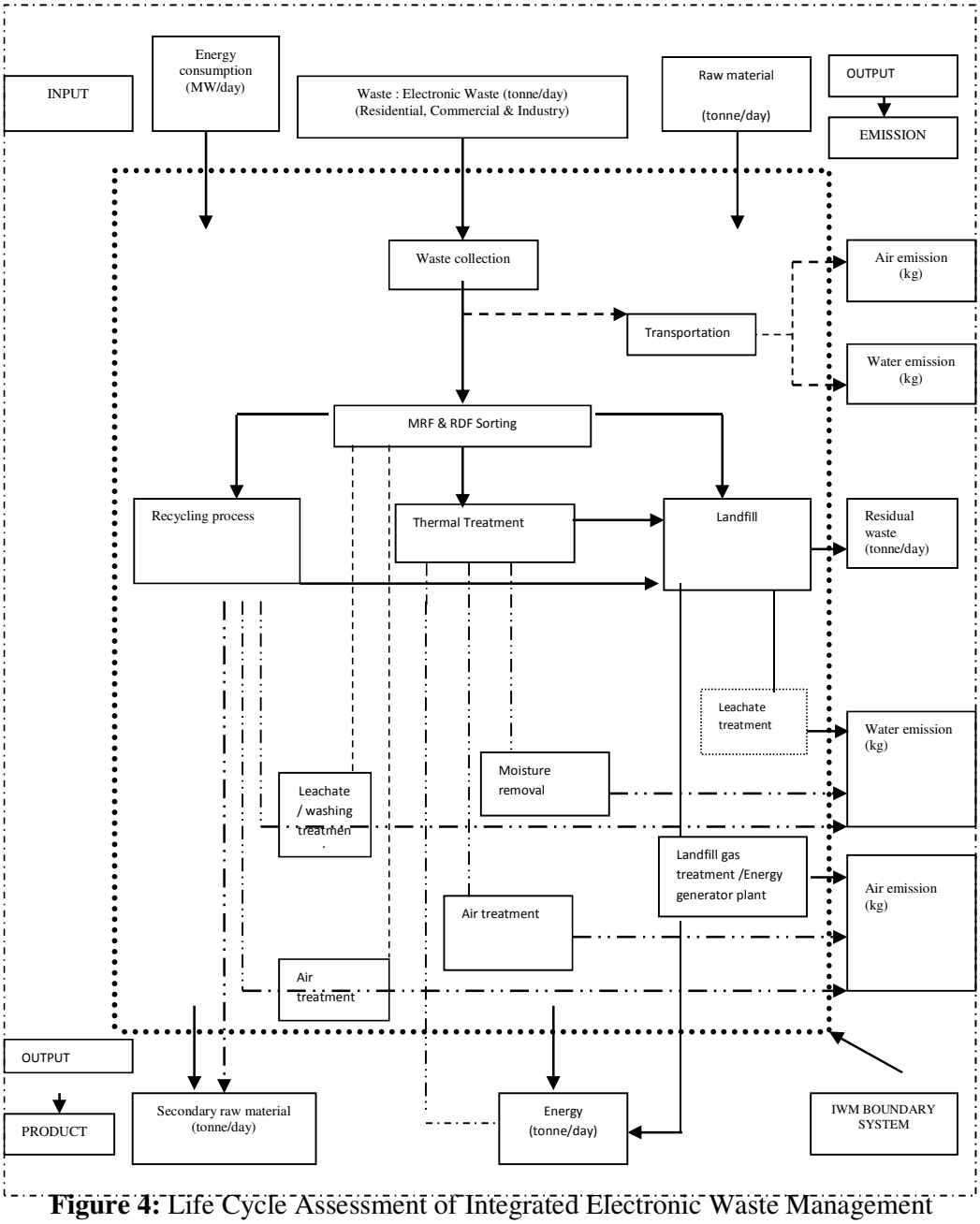

Figure 4: Life Cycle Assessment of Integrated Electronic Waste Management

4.0 CONCLUSSION

Life cycle assessment is a best technique that can be used to analyse an electronic waste management technology selection that practices integrated approach. The technique is able to produce data to be used in predicting the environmental effects exist due to activities generated by the integrated electronic waste management. The integrated electronic waste management technique is suggested as a one of the best management practice (BMPs) to handle electronic waste in sustainable manner.

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