COMPUTER WASTE MANAGEMENT AND AWARENESS

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...Dedicated to...

My beloved Father and Mother

Supian bin Jusoh and Rohani binti Wahab

My Brothers and Sisters

Thank You from the Bottom of My Heart for Being My

Inspirations

My Supervisor

Dr. Mohd Badruddin Mohd Yusof

For Being Patient and Give Me A Lot of Knowledge

And Lastly To All My Dear Friends

Thank You for Supporting Me

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ABSTRACT

Increasing volume of discarded electric and electrical waste (e-waste) in waste stream is one of the critical environmental issues faced by many countries. A survey was conducted in 2014 and 2015 at Johor Bahru Tengah (Western Zone) namely Skudai, Gelang Patah, Kangkar Pulai, Lima Kedai and Ulu Choh covering 600 public respondents and 65 randomly selected retailers. The objectives of the study were to identify the awareness among public and retailers on the management of computer waste as well as to estimates recycled computer waste. It is aimed at developing profiles of recyclers among public and computer retailers. Collected data were analysed using Predictive Analytics Software (PASW). Even though awareness on environmental risk of computer waste for both public and retailers were high, it did not reflect in their handling. Based on bivariate analysis, education was found to be significant at 99 percent confident level ($p<0.01$) in affecting awareness level. However for retailers, both the role of education and working experience were significant (i.e., $p<0.01$). Respondents with higher income and education tend to have higher awareness on effect of computer wastes towards environmental hazards. The awareness on valuable materials in e-waste was due to working experience and education. Total computer waste collected within the study time frame at the study areas were approximately 1,219 kg. Shops generated 658 kg of computer wastes within five months in 2014 and 561 kg in six months in 2015 (with an average of 131.6 kg per month in 2014 and 93.5 kg in 2015). As a result, the study indicated a high potential for computer waste recycling in the study areas. The study can help the authority in terms of providing a database needed to estimate e-waste generation in other regions as well as developing appropriate policies and facilities to improve e-waste management.

ABSTRAK

Peningkatan sisa elektrik dan elektronik (e-sisa) dalam aliran sisa menjadikannya satu masalah persekitaran yang kritikal dihadapi oleh banyak negara. Satu kajian telah dijalankan pada 2014 dan 2015 di Johor Bahru Tengah (Zon Barat) iaitu Skudai, Gelang Patah, Kangkar Pulai, Lima Kedai dan Ulu Choh melibatkan 600 orang awam dan 65 pemilik kedai yang dipilih secara rawak. Objektif kajian ini adalah bertujuan untuk mengenal pasti kesedaran tentang pengurusan sisa komputer di kalangan orang awam dan pemilik kedai serta menganggarkan jumlah sisa komputer yang dikitar semula. Kajian ini juga dijalankan untuk mengkaji profil orang awam dan pemilik kedai komputer. Data yang diperolehi dianalisis menggunakan Predictive Analytics Software (PASW). Walaupun kesedaran tentang bahaya sisa komputer di kalangan orang awam dan pemilik kedai adalah tinggi, namun ia tidak mengambarkan pengetahuan mereka dalam menguruskan sisa komputer dengan betul. Berdasarkan analisis bivarate, pendidikan orang awam mempunyai korelasi yang signifikan ($p<0.01$) iaitu 99 peratus aras signifikan. Manakala untuk pemilik kedai, pendidikan ($p<0.01$) dan pengalaman kerja ($p<0.01$) mempunyai korelasi yang signifikan. Responden yang berpendapatan tinggi dan berpendidikan lebih menyedari akan keburukan sisa komputer terhadap alam sekitar. Kesedaran tentang bahan bernilai dalam e-sisa dipengaruhi pengalaman kerja dan pendidikan. Jumlah sisa komputer yang terkumpul dalam tempoh kajian dijalankan adalah 1,219 kg. Jumlah sisa komputer yang diperoleh daripada pemilik kedai dalam lima bulan pada 2014 ialah 658 kg dan 561 kg dalam tempoh enam bulan pada 2015 (dengan anggaran 131.6 kg sebulan pada 2014 dan 93.5 kg pada 2015). Oleh sebab itu, kajian menunjukkan potensi yang tinggi untuk kitar semula sisa komputer di kawasan kajian. Kajian ini dapat membantu pihak yang bertanggungjawab untuk menyediakan pengkalan data untuk menganggarkan sisa komputer di rantau lain di samping membangunkan polisi dan fasiliti untuk meningkatkan pengurusan e-sisa.

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LIST OF SYMBOLS

*	-	Asterisk mark
n	-	Number of data items in sample
$p-$value	-	Significance level (either $p<0.05$ or $p<0.01$)
r_s	-	Spearman's rho
s	-	Standard deviation
x	-	Each value in the data sample
Σx	-	Sum of all data items
$\bar{x}$	-	Mean
Σ	-	Sum of

LIST OF ABBREVIATION

ACT	-	Australian Capital Territory
ARF	-	Advanced Recycling Fee
DOE	-	Department of Environmental
DOS	-	Department of Statistical
EIA	-	Environmental Impact Assessment
EPR	-	Extended Producer Responsibility
EQA	-	Environmental Quality Act
EQR	-	Environmental Quality Report
FOEN	-	Federal Office for the Environment
INOBAT	-	Stakeholder Organisation for Battery Disposal
ICT	-	Information and Communication Technology
LRHA	-	Law for Recycling Specified Kinds of Home Appliances
LPUR	-	Law for the Promotion of Effective Utilisation of Resources
MoEF	-	Ministry of Environment and Forests
NEPC	-	National Environment Protection Council
NEPM	-	National Environmental Protection Measure
OEM	-	Original Equipment Manufacturer

ORDEE	-	Ordinance on 'The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment
PASW	-	Predictive Analytics Software
PRO	-	Producer Responsibility Organisations
PBB	-	Polybrominated Biphenyls
PBDE	-	Polybrominateddiphenylether
RCRA	-	Resource Conservation and Recovery Act
RoHS	-	Restriction of Hazardous Substances
SENS	-	The Stiftung Entsorgung Schweiz
SLRS	-	The Swiss Lighting Recycling Foundation
SPSS	-	Statistical Packages for Social Sciences
SWICO	-	The Swiss Association for Information Communication and Organizational Technology
TCLP	-	Toxicity Characteristic Leaching Procedure
UEEE	-	Used Electrical and Electronic Equipment
WEEE	-	Waste Electrical and Electronic Equipment

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CHAPTER 1

INTRODUCTION

1.1   Overview

In the past 30 years, research showed that usage of electric and electronic equipment has changed people's daily activities (Townsend, 2011). With the rapid improvement in information and communication technologies, the increasing volume of most electronic devices, together with the lower prices have led to an extremely shortened lifespan for most electric and electronic equipment (Fraige *et al.,* 2011). Malaysia, being an economically developing country in South East Asia is no exception. The drastic changes in economic, socio-economic, education as well as life styles of the citizens have indirectly generated e-waste which has negative effects on the environment due to the growing amount of electric and electronic wastes in our current waste stream.

E-waste refers to obsolete electric and electronic equipment which is no longer functional. According to Taghipour *et al.* (2012), there were 20 to 50 million metric tonnes of e-waste produced worldwide. Robinson (2009) reported that e-waste formed between 1 to 3 percent of total solid wastes globally. E-waste consists of metals such as aluminium, lead, zinc, valuable metals, platinum group metals, and rare earth elements (Menad *et al.,* 2012), which if not properly disposed, could cause danger to public health and environment.

Many researches have been conducted around the world, including a research conducted by Li *et al.* (2011) in Guiyu, China. Li *et al.* (2011) believed that the implementation of regulations is crucial in curbing environmental impacts and controlling the volume of e-waste. It was feared that e-waste from developed counties were sent to developing countries which lack appropriate and effective management. Luther (2010) stated that some e-waste was exported to developing countries where the workers were not aware of the consequences. This has caused a serious environmental hazard to people's health. This is further supported by Zhu *et al.* (2012) who realized the hazardous informal recycling activities in certain countries. In addition, the existence of informal recycling lead to insufficient e-waste supply of formal recycler.

Dwivedy and Mittal (2013) carried out a survey on willingness of residents to participate in e-waste recycling in India. These researchers found that economic benefits are necessary to encourage respondents to participate in e-waste recycling. On the other hand, Song *et al.* (2012) stated that awareness of respondents in Macau towards willingness to pay for recycling e-waste was relatively high. However, they had limited knowledge on how to treat e-waste properly. Therefore, educational programs are vital in controlling e-waste volume and its impacts on the environment. Gaidajis *et al.* (2010) and Taghipour *et al.* (2012) agreed that management of e-waste needs to be rationally designed and constructed to minimize e-waste generation in the future.

The situation is similar in Malaysia where according to Guerrero *et al.* (2013), the improper collection and lack of facility for waste collections, as well as, inappropriate regulations are challenging factors to e-waste recycling. Therefore, it was crucial that a survey be carried out in the growth area of Johor Bahru Tengah (Western Zone), Johor to determine the exact situation of e-waste's awareness amongst the public and its generation.

1.2   Statement of Problem

Based on the Environmental Quality Report (EQR), the amount of e-waste category (SW 110) generated was 134,036 (DOE, 2009), 163,340 (DOE, 2010), and 152,722 (DOE, 2011) tonnes. The amount was somewhat less in 2012 (78,278 tonnes). These were disposed of at 153 off-site facilities in 2012. There were only 138 such facilities in 2009. The number of off-site facilities keeps increasing every year indicating the growing volume of e-waste in Malaysia.

According to Sidique *et al.* (2010), education and convenience is important to enhance awareness of recycling facilities. These factors were also supported by Nixon *et al.* (2009). In addition, Saphores *et al.* (2012) stated that gender and marital status were significant to explain the willingness and behaviour to recycle while income status was not statistically significant. Further, Song *et al.* (2012) stated that education level, age group, and income were significant in order to identify the willingness to pay for e-waste recycling.

However, computer waste data were not specifically mentioned in the EQR. This data was obtained from Department of Statistical Malaysia where in 2015, computer waste was estimated to be approximately 418,897 tonnes. This shows that obtaining computer waste data from retailers is important in

identifying production of computer wastes in Johor Bahru Tengah (Western Zone).

The awareness from public and retailers was also determined for this study. Significant variables from demographic data were defined to show the awareness on e-waste management.

The survey was conducted in Johor Bahru Tengah (Western Zone) involving both public and retailers, and their recycling behaviour towards computer wastes management. The interview sessions were performed by randomly selecting the respondents.

1.3   Objectives of Study

The objectives of the study are:

1.   To identify the awareness of computer waste management among the public and   retailers in Johor Bahru Tengah (Western Zone).
2.   To develop profiles of computer waste recyclers among the public and retailers.
3.   To estimate the quantity of computer waste collected from retailers and its recycling potential in study area.

1.4   Significance of the Study

The findings on the amount of computer waste obtained from the survey in Johor Bahru Tengah (Western Zone) can be additional resources for future research. The findings can also be compared to other zones in Johor. Hence,

appropriate strategy can be suggested to minimize computer wastes at a particular zone.

Furthermore, a few demographic variables (e.g. age, income, working experience etc.) were used in analysing their role in affecting awareness of computer wastes management in study areas. Additionally, interviews from retailers are essential because of their knowledge of the obstacles and inappropriate existing regulations in handling e-waste. Therefore, local authorities and government are responsible to encourage and educate respondents on e-waste management before redesigning the most appropriate regulations and legislations to deal with its minimization.

1.5 Scope of Study

The scopes of the study include:

1. The survey conducted in Johor Bahru Tengah (Western Zone) to represent the State of Johor.
2. A list of survey questionnaires designed to meet the objectives of the study.
3. Collection and analysis of demographic background data on both groups of respondents (i.e., public and retailers).
4. An assessment of the awareness of the study groups towards computer wastes recycling programs in study areas.
5. Randomly selected retailers to obtain their opinions and collect quantitative data on computer waste.

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