

E-Waste and Sustainable Supply Chain A Thai Reverse Logistics Perspective

Associate Professor Dr. Hermann Gruenwald¹

¹Burapha University
International College (BUUIC)
Logistics Management
Bangsaen, Thailand
GruenwaldH@yahoo.com

ABSTRACT

This paper provides a Thai logistics perspective on electronic waste (e-waste). Thailand is in a unique position where it is a recipient of electronic waste as well as a producer of electronic waste. Electronic waste by definition is electronic devices at the end or near the end of their useful lives. E-waste represents 2% of America's trash in the landfills but equals 70% of overall toxic waste. Electronic items that are considered to be hazardous include, but are not limited to: television sets and computer monitors that contain cathode ray tubes, LCD desktop monitors, LCD televisions, plasma televisions, portable DVD players with LCD screens and mobile phones. Cell phones and other electronic items contain high amounts of precious metals like gold or silver. Americans annually dump phones containing over \$60 million in gold/silver. For every one million mobile phones that are recycled, 35,274 lbs of copper, 772 lbs of silver, 75 lbs of gold, and 33 lbs of palladium can be recovered. Only 12.5% of e-waste is currently recycled. This study used an on-line survey to measure the perception of young logistics professionals in relation to e-waste. How they deal with the ethical issue of e-waste on a personal and professional level, as well as their technical knowledge in relation to e-waste and supply chain management and their applications in a Thai context. Outdated and damaged electronics are shipped from the USA and Europe to Thailand to be resold, and many end up on the street markets at MBK and Pantip Plaza as second-hand computers and mobile phones. But the vast majority are actually e-waste and are harvested for their precious metal content under mostly unsafe conditions for the environment and migrant labor workers in Thailand and the neighboring countries. The domestic production of e-waste in Thailand is an even bigger issue as Thai people replace their old TV sets for digital LCD TVs, replace their old computers for tablet PCs and most of all upgrade and exchange their mobile phones on less than annual basis. The e-waste is not only generated on a personal level but also by corporations and government agencies replacing their infrastructure often just before October 1, the start of the new physical year for government agencies. The study found that the awareness of e-waste in the Thai population is relatively low and the participants were not aware what e-waste is and the magnitude of problems caused by it as well as the global supply chain consequences. Sustainable supply chain solutions allow for the reuse, recycle and recover options for e-waste under controlled conditions and can be very profitable for society as well as the reverse logistics companies recovering the commodities.

Keywords: e-waste; IT; recycling; reverse logistics; sustainable supply chain;

ACM Classification Keywords

B. Hardware

B.4 INPUT/OUTPUT AND DATA COMMUNICATIONS

B.7 INTEGRATED CIRCUITS

H.3 INFORMATION STORAGE AND RETRIEVAL

INTRODUCTION

Consumer electronics like VCRs, DVD players, radios, television sets and other small appliances as they are disposed of are collectively referred to as e-waste. Electronic waste has become one of the fastest growing waste streams in the USA and developed countries. It is estimated that 50-80% of the e-waste collected in the USA for recycling is being exported and predominately to Asia. Only 25% of the total electronic waste is being collected for recycling 75% of the e-waste is discarded in landfills or incinerators, releasing dangerous toxins into the land and air. While e-waste represents just two (2%) percent of America's trash in landfills, it equals 70% of overall toxic waste. New electronic equipment reached the market faster and faster, which not only consumes raw materials from the mining to energy during the manufacturing process to contamination when disposed of. As new products are consumed old electronic items become outdated and obsolete at a rate of about 55 million tons per year worldwide.

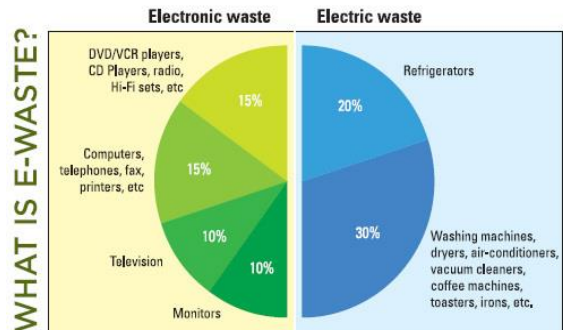


Figure 1. What is e-Waste?

(Source:Greenpeace)

The one man's trash is the other man's treasure, at least on the surface and first glance. E-waste is being shipped from the USA and Europe (Rotterdam) to West Africa (Ghana and Nigeria), Asia predominantly India and Pakistan as well as Guiyu in China, where unskilled and often migrant workers rummage through mountains of TV and computer monitors with leaded glass and smash printed circuit boards to recover materials such as aluminum, beryllium, cadmium, copper, mercury, nickel as well as gold and silver and platinum. But the incineration also releases dioxin and carcinogens which leads to heavy metal contamination of the atmosphere. Worldwide regulator action came in place with the Basel Convention, and in Europe specifically with the Waste Electrical and Electronic Equipment Directive (WEEE) came into force in 2003, to regulate and restrict the export and reuse of e-waste which is often declared as pre-owned electronic equipment to be resold and reused in the so called emerging markets, while in fact it is harvested there for its commodities and the remains are disposed off, often improperly.



Figure 2. Export of E-Waste (Source Greenpeace)

LITERATURE REVIEW

The literature review looked at the current industry practices as well as international regulations as in Alter (2000) who looked at environmentally sound management of the recycling of hazardous wastes in the context of the Basel Convention and the WEEE Directive (2003). Salhofer and Tesar (2010) looked at the removal of components containing hazardous substances from small consumer electronics. Gmünder (2007) assessed the optimal manual dismantling depth of a desktop PC in China based on eco-efficiency calculations and Jain and Sareen (2004) assessed the E-waste in India. While the Japan Electronics and Information Technology Industries Association (JEITA) (2005) looked at the recovery, treatment and recycling of IT equipment. JEITA. Kojima and Yoshida (2004) explored recycling of E-waste in Asian countries. In the same year (2004) Mungcharoen researched specifically the status and issues of E-waste recycling in Thailand as part of a sustainable supply chain and reverse logistics.

RESEARCH METHODOLOGY

Survey Instrument

The researcher developed his own survey instrument using a five point Likert scale to measure the responses which were gathered using an on-line survey. The Burapha University Moodle based e-learning system was used to administrate the survey to logistics management students. The survey instrument was created in English language. The survey instrument used self-reported data regarding the perception of the individual logistics students along the spectrum associated with e-waste generation, reduction, reuse, recycling and reverse logistics in a Thai sustainable supply chain context.

Sample Preparation

The convenience sample was selected from Burapha University, Bangsaen, Chonburi, Thailand students, namely students who studied at the Burapha University International College and declared logistics management as their major. Of the 50 Thai participants 33

(66%) were female, while 17 (33%) were male. The students ranged in age from 19 to 24 while the majority of the students were between 20 and 21 years old, with the oldest being 24 years of age. This was a convenience sample which is representative of junior undergraduate logistics management students in English language programs in Thailand. The sample may not represent typical Thai students in Thai logistics programs, as these students come from a different socio economic class. The ratio of male/female students is typical for Thai universities in general and logistics management programs specifically.

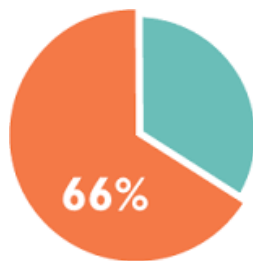


Figure 3. 66% Female / 34% Male Respondents

DATA ANALYSIS

The collected data was analyzed electronically using SPSS for the statistical analysis the findings were then summarize in an excel spreadsheet for further data analysis and development of patterns as a base for the development theory. This quantitative study followed standardized statistical analysis practices, to verify both the instrument and the results. The content of the study was further analyzed to form theory about the answers found in the various themes related to e-waste and sustainable supply chain practices.

RESULTS

The results of this study can be divided into the following categories which relate to the perception of Thai logistics students in regards to e-waste and its treatment in terms of reverse logistics and local practices both from a personal and industry standpoint

1. How often do you purchase a new mobile phone?

72% of the respondents purchase a new mobile phone at least once a year, and 4% change their phone every six month or even three month depending how often a new phone like the i-phone enters the market, in order to upgrade to the latest model.

Table 1. How often do you change your mobile phone.

Mobile Phone Purchases		Response	Count	Frequency
Attempts	50	3 month	2	4.00%
Facility index	6.00	6 month	2	4.00%
Standard Deviation	23.99	1 year	36	72.00%
Discrimination Index	- 13.65	18 month	3	6.00%
Discriminative Efficiency	- 31.58	2 years	7	14.00%

2. What do you do with your old phone?

The majority of the respondents 56% sell their old phone or 26% throw it away followed by giving it to a friend (6%) only 10% recycle and 2% destroy it.

Table 2. Old Phone Discharge

Old Phone Discharge		Response	Count	Frequency
Attempts	50	throw away	13	26.00%
Facility index	6.00	sell it	28	56.00%
Standard Deviation	23.90	give it to a friend	3	6.00%
Discrimination Index	-22.84	bring it to a recycling place	5	10.00%
Discriminative Efficiency	-53.51	destroy it	1	2.00%

3. What are the important factors when you purchase a mobile phone?

The following decisions play key roles when purchasing a new mobile phone according to the respondents. Amazingly sound quality of the phone is no longer an issue it is taken for granted, but other functions are important to the buyer, price plays the second highest role, it is a trade-off between price and functionality, the camera is an important phone as nowadays mobile phones are a combination of high

resolution camera and phone from a buyer's perspective. Environmental friendliness is very low on the list on the purchase decisions only 4% of the respondents take the environmental impact of mobile phones into consideration when making a purchasing decision.

Table 3. Decision Criteria for Purchasing Phone

Purchasing Decisions		Response	Count	Frequency
Attempts	50	functions	31	62.00%
Facility index	4.00	camera	5	10.00%
Standard Deviation	19.79	price	12	24.00%
Discrimination Index	-5.57	environmental friendly	2	4.00%
Discriminative Efficiency	15.89	sound	0	0.00%

4. What is your solution for e-waste?

Interestingly enough the participants (58%) were aware that the solutions for e-waste start with the consumer and that reduce, reuse and recycle is the right answer chosen by 29% of the respondents. Only 3% reuse the electronic devices, 5% reduce the number of electronic devices they purchase by using them longer. 11% of the respondents recycle the used electronic devices and only 2% throw the items away, which confirms their previous answer to

question number two, there is still a gap between what is and what should be the best practice in terms of e-waste in Thailand based on the responses received in the survey.

Table 4. Your Solution for E-Waste

Solution for E-Waste		Response	Count	Frequency
Attempts	50	reduce	5	10.00%
Facility index	58.00	reuse	3	6.00%
Standard Deviation	49.86	recycle	11	22.00%
Discrimination Index	44.30	reduce, reuse and recycle	29	58.00%
Discriminative Efficiency	55.54	through it in the garbage	2	4.00%

CONCLUSION

E-Waste is the fastest growing waste stream in Thailand, as ASEAN is both a recipient of e-waste from the USA and Europe as well as a producer of e-waste, with the growing number of mobile and electronic devices. The Thai consumers are less concerned about the environmental impact of the phone than its functionality and change their phones more often even than US consumers. There is no market for second hand US phones in Thailand, those days are long gone along with the

dominance of Motorola with its racer calm phones. When Thai consumers dispose of their phones they opt to give it to a friend or simply throw it away. The solution is better environmental awareness and education to focus on the 3R endeavors reduce, reuse, recycle, by recycled and safe disposal. This is easily said but the reality is different. Reverse logistics has to play a more important role in the sustainable supply chain, by returning the e-waste at the end of its useful life to a controlled recycling process, where the valuable substances can be recovered in an environmental friendly way while protecting the staff involved in doing the work as well as the receiving country and region to not negatively impact their environment and economy in the ASEAN country like Thailand. It is therefore highly recommended to implement the following flow of e-waste as depicted in Figure 4.

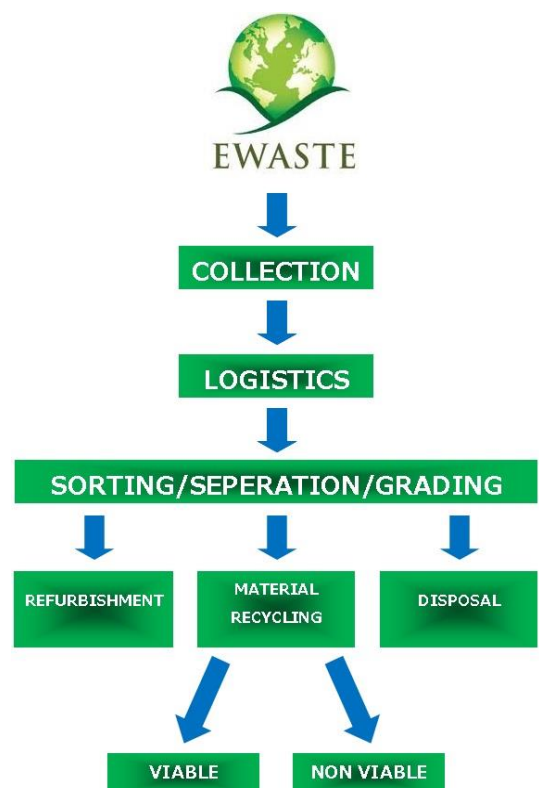




Figure 4. E-Waste Return Logistics and Recycling

RECOMMENDATION

It is recommended to follow-up this study with a large scale more comprehensive and geographically dispersed study in Thailand. And for comparison purposes extend the study to other ASEAN countries, which may show different use patterns in terms of mobile phone purchasing and e-waste behavior on all levels of the sustainable supply chain from cradle to grave.

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ABOUT THE AUTHOR

Associate Professor Dr. Hermann Gruenwald holds an engineering degree from Germany (Dipl. Ing. (FH)), a Master of Architecture from the University of Houston, Texas (UofH), a Master of Education from the University of Oklahoma, Norman, Oklahoma a MBA from Southern Methodist University (SMU) in Dallas, Texas and a Ph.D. from OU.

He held faculty and administrative appointments at the University of Oklahoma, University of Phoenix, University of Alaska, Mahidol University and Burapha University. He taught graduate and undergraduate business courses related to IT and logistics, and has numerous peer-reviewed publications and funded research projects.

Dr. Gruenwald has helped to establish logistics programs in the USA, former Soviet Union, The Philippines and in Thailand and has been actively involved in funded research and authored several business textbooks.