e-waste Management
in Sri Lanka

Department of Accounting
Faculty of Management Studies and Commerce
University of Sri Jayewardenepura
Sri Lanka

e-waste Management in Sri Lanka

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Dedicated to

Emeritus Professor M. W. Wickramarachchi
The founder of the Department of Accounting,
Faculty of Management Studies and Commerce,
University of Sri Jayewardenepura, Sri Lanka
for
laying the foundation
for the new generations of accountants to explore the world!!

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We would also like to extend our gratitude profoundly to the academic and non-academic staff members of the Department of Accounting while especially acknowledging the support of the Head of the Department, Dr. W G S Kelum for his constant encouragement and support throughout this period. Also our especial thanks go to the Vice Chancellor of the University of Sri Jayewardenepura, Prof. Sampath Amaratunga, Dean of the faculty of Management Studies and Commerce, Dr. U Anura Kumara and other staff of the University for their continuous support. It is with heartfelt gratitude we acknowledge the support of Prof. Samanthi Senaratne in expediting the printing process in order to get this book on time. Without her personal commitment this publication would have been undoubtedly much delayed. Also we would like to thank Mr. PDC Udayashantha, Senior Lecturer of the Department of Accounting, for his last minute comments and encouragements.

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Finally we humbly apologize for any errors or omissions that may appear anywhere in this book.

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15 October , 2015

Head of Department's Message

As the Head of the Department of Accounting, I am indeed happy to write this message for the book on "e-waste Management in Sri Lanka" that is launched in October, 2015 in Colombo, Sri Lanka. This publication is another pioneering initiative of the Department of Accounting, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, the premier academic accounting education institute in the country.

The Department of Accounting has always provided thought leadership to the accounting profession from its inception in 1992 while pioneering many initiatives to improve awareness of contemporary developments in accounting and allied fields. In recent years, the Department has carried out many activities having understood the importance of sustainability accounting and the role of education. Introducing a novel course unit on Sustainability Management Accounting in its curriculum in 2012, conducting a forum on Sustainability Management Accounting in 2014, and hosting the Global Conference of Environmental and Sustainability Management Accounting Network (EMAN) in 2015 are a few of the activities that were undertaken in this direction. Further, the Department has published several books, journals and documentary videos on environmental/ sustainability management.

I would especially like to congratulate the editor of this publication, Mr. A. D. Nuwan Gunarathne, lecturer of the Department, and his team of students who formed the Publication Committee of AFMA (the student body of the Department) for their laudable endeavour.

Dr. W. G. S. Kelum
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15 October , 2015

List of Abbreviations

AEHA	Association for Electric Home Appliances
BOI	Board of Investment
CCTV	Closed Circuit Television
CEA	Central Environmental Authority
CLEAN	Community Lead Environment Action Network
COP	Conference of the Parties
CPCB	Central Pollution Control Board
CRT	Cathode Ray Tube
CSR	Corporate Social Responsibility
DDT	Dichloro Diphenyl Trichloroethane
EEE	Electrical and Electronic Equipments
EPA	Environmental Protection Agency
EU	European Union
EWSR	European Union Waste Shipment Regulation
FBR	Federal Board of Revenue
GEF	Global Environmental Facility
HAPL	Home Appliance Recycling Law
ICT	Information and Communication Technology
LDCs	Less Developed Countries
LPUR	Law for the Promotion of Effective Utilization of Resources
MAIT	Manufacturer's Association for Information Technology
MII	Ministry of Industry and Information
MOEFI	Ministry of Environment & Forests of India
MT	Metric Tons
NDMA	National Disaster Management Authority
NGO	Non Government Organization
NIP	National Implementation Plan
NTACC	National Technical Advisory Committee on Chemicals
POPs	Persistent Organic Pollutants
RCRA	Resource Conservation and Recovery Act
StEP	Solving the E-waste Problem
SWM	Scheduled Waste Management
UNEP	United Nations Environment Programme
UNU	United Nations University
UST	Underground Storage Tank
WEEE	Waste Electrical and Electronic Equipments

Preface

Every year the Publication Committee of the Accounting and Financial Management Association (AFMA), the student body of the Department of Accounting (DA), University of Sri Jayewardenepura (USJ), Sri Lanka, engages in some publication-related work. Over the past few years the committee has been publishing a magazine aimed at the GCE Advanced Level students who sit for their Advanced Level examinations, a highly competitive university entrance examination. This year when twenty-four students from the second year (because the DA had an intake of two hundred and forty students who were divided among the ten committees of AFMA) were allocated to me, as the person in charge of the AFMA Publication Committee, I wanted to do something different from what the Committee had been doing over the last few years. I was also lucky enough to get a set of students who are from a different background but keen to take up the challenge of doing something new.

After many years of engagement in sustainability and its accounting-related aspects, especially Environmental Management Accounting (EMA), I was deeply disturbed by the flow of electronics and electrical equipment into the Sri Lankan market and the lack of a systematic approach to their disposal at the end of their lifecycle. With a few exceptions, the majority of Sri Lankans and enterprises are not aware of the dangers and/or opportunities that these waste items create. By looking at the speed at which this phenomenon was taking place I was really concerned about whether we were depriving the future generations of their ability to enjoy the same economic and social prosperity suggested in the Brundtland Report (1987) several decades ago. I was then looking for an avenue to explore the Sri Lankan status of e-waste management when I met the Publication Committee of AFMA.

So, it was a marriage of my personal motivations and the aspirations of the Publication Committee to travel along this untraversed path. The students of the Publication Committee of AFMA, being undergraduates of an accounting degree program, were not very conversant with the subject of e-waste. But we were well aware of the lack of awareness of e-waste management as citizens of a country that has been steadily progressing towards a middle income country with the high level of economic growth as reported by Central Bank of Sri Lanka (2013). We had started using computers, printers, laptops and notebooks while switching to smart phones throwing away our old mobile phones. Televisions, radios, refrigerators and electronic equipment such as washing machines, ovens and toys are now not luxury goods for many Sri Lankans. At the same time, over the recent years there has been a proliferation of Compact Florescent Lights (CFL) used by both households and corporations in a bid to save electricity because of the very high cost involved. But quite amazingly, we are not aware of the treatment options available for these items. We were simply and blindly throwing them away with other waste material. Sometimes we were quickly collecting pieces of a CFL bulb, when it was broken, in fear of someone getting injured due to the pieces of glass, without knowing the dangers of inhaling mercury. We were throwing away these electronic and electrical items without extracting the valuable metals in them. There was obviously an urgent need to study and educate the public on the dangers as well as opportunities in proper e-waste management in Sri Lanka.

I then thought of making use of this need/opportunity with the Publication Committee of the AFMA. The subject matter, e-waste, was new to me as well to the students. After perusing the literature, I first decided on the initial chapter plan of this book which was often changed as we progressed. The biggest challenge arose in collecting data for the study. Although we relied heavily on the existing rich literature available on the subject, we had to collect some primary data as very little had been written about Sri Lanka. We held several interviews with the relevant officers of the Central Environmental Authority (CEA) and also contacted them over the phone for further clarifications. Then we got the registered list of e-waste recyclers from the CEA and contacted them. We visited all the companies referred to in the book to observe these practices at first hand. We interviewed several managers of each company who are in charge of these practices. Moreover, we always referred to various other documents for triangulation purposes. Sometimes we were pleasantly surprised that some companies were not at all hesitant to share their information with us. Now, in retrospect, we realize that we had been collecting data for this study over a period of a minimum of one year, albeit not at the same level of intensity. This book is therefore a result of an adventurous and a challenging journey that we undertook.

I therefore earnestly believe this publication would contribute to fill the lacuna in studies on Sri Lanka with respect to e-waste while enhancing and developing the soft skills of the students of the Department of Accounting.

Editor
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October , 2015

Editor's Note:

E-waste, an unnoticed threat or an opportunity?

Chapter One

1.1 Global challenge of e-waste

Our lifestyle has become so advanced (or rather sophisticated) and it is quite impossible to think of living without mobile phones, computers, laptops, televisions, refrigerators, washing machines or even CFL bulbs. These Electrical and Electronic Equipments (EEE) become a waste item called "e-waste" or "WEEE (Waste Electrical and Electronic Equipments)" once they come to the end of the life. E-waste has now become a global challenge in both developed and developing countries. The sheer quantity of e-waste speaks volumes of its potential future risk, if it is not managed properly. For example, according to the UNU (2014), the global generation of e-waste was 42 million metric tons (mt) in 2014. Out of this, 6 mt was related to Information and Communication Technology (ICT). This also means 6 kilograms of per capita e-waste generation per year. These figures are expected to grow year by year.

Though the consumption and use of EEE is most prevalent in developed countries, in the recent years, the developing countries too show a growing trend of consumption of these modern day equipments. Yet, most of the developing countries lack proper mechanisms or infrastructure or even awareness of sound treatment and disposal of e-waste. Sometimes, these countries have become dumping yards of e-waste generated in developed countries. Consequently, e-waste in these countries will be treated in suboptimal ways by the informal sector (UNEP, 2012) leading to many environmental and social issues/threats.

However, there is an opportunity if e-waste is properly managed. E-waste contains lots of valuable materials such as gold, silver, platinum and palladium. If properly managed, these materials can be recovered while reducing the burden on the environment for raw material extraction. In addition to this positive impact on environment, e-waste management has positive social impacts too. E-waste items can satisfy the needs of different communities who can't afford to buy brand new items. Moreover, e-waste recycling can open up new industries while creating sustainable avenues for something that could become a social and health problem. Hence, e-waste offers threats to humans and the environment while also presenting an opportunity, if managed properly.

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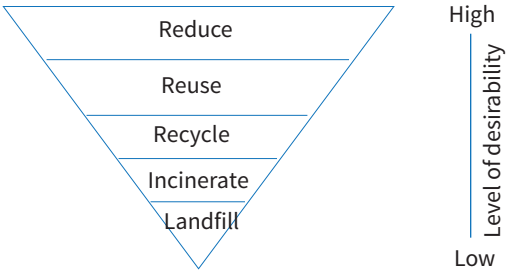
1.2 Sound e-waste management

In order to derive the full benefit while minimizing the negative consequences it is necessary to manage e-waste properly. The waste management hierarchy, discussed in traditional waste management, can be applied to e-waste management too. This hierarchy presents several options of managing e-waste. These options are listed below in their descending order of desirability;

- Reduce
- Reuse
- Recycle
- Incinerate
- Landfill

E-waste management hierarchy



This lop-sided hierarchy highlights that the first options are more environmentally and socially sustainable and desirable than the options at the bottom of the hierarchy.

Reduction option is the most desirable so that there is no e-waste to manage if we reduce the generation of e-waste. However given our desire to own the latest, the most sophisticated and technologically advanced EEE, reducing e-waste becomes a challenging option unless the culture of consumption and disposal is reconsidered.

Reuse option involves the use of e-waste items for the same purpose or for some different purpose. Analysis shows that e-waste has many components that can be reused. Yet, reuse can be a challenging task at the individual level, but at the corporate level this is a promising approach. For example, some Sri Lankan companies reuse the usable components of CFL bulbs before recycling them.

Recycling option involves sorting, dismantling and processing e-waste to extract the usable materials. Like any form of recycling, e-waste recycling also involves the conversion of device streams into material streams.

All e-waste items can't be disposed in the above described three ways. There are technological and environmental reasons among many other. *Incineration* of e-waste involves burning of certain items that cannot be reused or recycled. As the least preferable option, the items that can't even be incinerated will have to be properly *land filled*. However, the last two options of the waste management hierarchy can create many detrimental social and environmental implications.

1.3 Rethinking as a new option

Rethinking is an approach that is more akin to reduce option described above. Owing to the nature of e-waste generation it is now suggested that rethinking as an option should be added at the top of the waste management hierarchy. This option calls for a change in the way we consume or acquire EEE. For example, rather than buying a fax machine, a photocopier, a scanner and a printer, one can now buy just one machine that performs all the functions. This negates the need to buy three different machines which will leave only one machine to dispose finally. Yet, this option has to be aligned with technological developments and individual preferences. This book therefore is an attempt to enlighten the readers on the different e-waste management options available nowadays.

1.4 The order of the book

Though the title of the book is "e-waste Management in Sri Lanka", we have presented many other perspectives on e-waste with the intention of creating awareness and commitment to this global challenge. The next few paragraphs explain the focus of each chapter of this book.

Chapter One, while providing the introduction to the book, provides definitions of e-waste and explains different types of e-waste and their cultural, social and environmental impact. As the introductory chapter of this book, it lays the foundation for understanding the severity of e-waste.

The next chapter focuses on the current status of e-waste. It first highlights some alarming global and regional figures of the e-waste generated. Global flows of e-waste and the status of Asia is next discussed in the chapter, which focuses not only on the emerging Asian economies such as India and China but also on some developed countries such as the USA and Japan to understand the disparities between developed and developing countries in the matter of e-waste management.

Chapter Three covers the regulatory aspects of e-waste management. Firstly, it focuses on the Basel, Rotterdam and Stockholm Conventions that provide the global platform for managing e-waste. While discussing the key features of these global conventions, the chapter highlights the impact on Sri Lanka or the status/response of Sri Lanka in regard to these conventions. The chapter next covers country-specific e-waste regulatory aspects. The focus is on highlighting regulatory developments in developed countries such as the USA, the UK, Japan and Germany and developing countries such as India, China, Pakistan and Bangladesh. Also the chapter covers the existing, yet to be developed, regulatory aspects in Sri Lanka before providing a comparison between legal aspects of e-waste in developed and developing countries.

Chapter Four is on e-waste management in Sri Lanka. It addresses e-waste management options and highlights the importance of the recycling option. It then goes into details of the e-waste recycling chain/process broken into three major steps: a) collection, b) sorting/dismantling and pre-processing, and c) end-processing. The chapter then

addresses the recycling process of different types of e-waste in Sri Lanka while highlighting the e-waste recyclers and their focus activities. The chapter also highlights some national level initiatives taken by CEA, the environmental regulatory body of the country.

The last chapter of the book, Chapter Five, presents the challenges and the way forward in managing e-waste in Sri Lanka in an attempt to showcase the present and the future of e-waste management in a developing country context. The chapter addresses some common challenges faced by e-waste recyclers, which are mostly interlinked. Next, it suggests recommendations for meeting the current challenges by focusing on institutional/ policy level support and general business recommendations for the recyclers. Finally, the chapter sheds some light on the potential role of an accountant in managing e-waste in an enterprise.

Introduction to E-Waste

Chapter Two

2.1 E-waste

With rapid economic and technological development throughout the world, a lot of Electrical and Electronic Equipments (EEE) came into human use and markets. Most of these items soon become outdated with the advancements in technology. Thus, these items become waste requiring proper management in order to reduce their environmental and social impact. This waste, called "e-waste", is becoming a major issue in both developed and developing countries. In the Sri Lankan context also the accumulation of e-waste is creating a major issue in waste management.

It is important to understand what e-waste means. The following are some definitions given by different organizations:

> *"E-waste is the term used to describe old, end-of-life or discarded appliances using electricity. It includes computers, consumer electronics, fridges, etc. which have been disposed of by their original users."*
>
> *-E-waste guide (2008)*

> *"E-waste refers to obsolete, broken, or irreparable electronic devices. E-waste is any refuse created by discarded electronic devices and components as well as substances involved in their manufacture or use."*
>
> *-Environmental Protection Agency (EPA)[1] (2013b)*

E-waste has also been defined as WEEE (Waste Electrical and Electronic Equipment) by the European Union in a directive (2012/19/EU) released on July 4, 2012. The directive designates safe and responsible collection, recycling and recovery procedure for all types of e-waste.

2.2 Types of e-waste

The life span of electronic goods is becoming shorter and the equipment we throw away as unwanted equipment is increasing in number. Accordingly, several types of e-waste can be identified.

[1] *EPA an agency of the U.S. Federal government created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress. The formation of EPA was proposed by President Richard Nixon and it began operations on December 2, 1970.*

– IT and telecommunication equipment:
Personal computers, telephones, mobile phones, laptops, printers, scanners, photocopiers, notebooks, notepads, pocket and desk calculators, telex machines

– Entertainment appliances:
Televisions, VCR/DVD/CD players, hi-fi sets, radios

– Household appliances:
-Large category: Washing machines, dryers, refrigerators, air conditioners
-Small category: Vacuum cleaners, coffee machines, irons, toasters

– Lighting equipment:
Fluorescent tubes and lamps, sodium lamps, CFL bulbs, etc. (except incandescent bulbs, halogen bulbs)

– Electric and electronic tools:
Drills, electric saws, sewing machines, lawn mowers

– Security and health care equipment:
Surveillance and control equipment (e.g. CCTV cameras, scanning equipment), and medical instruments and equipment (e.g. x-ray and heart lung machines)

– Toys, leisure and sports equipment:
Electric trains or car racing sets, handheld video game consoles, sports equipment with electric or electronic components.

2.3 Environmental impacts of e-waste

Unmanaged e-waste could create severe environmental damage. Without regard for the possible threats, large and significant amounts of e-waste containing hazardous chemicals are dumped into open land and waterways. Not only has this created a serious risk to human life but also significant risks to the environment. These risks are associated with air, land, water, soil and other environmental pollutions.

Air pollution

Incineration and open burning are the largest known and most frequent methods used to deal with e-waste. Components that cannot be recycled are being incinerated and open burning is frequently done to recover precious metals of electronic equipment such as gold, silver and copper from e-waste. Open burning and incineration results in releasing and dispersing heavy metals and toxic substances such as lead, mercury and cadmium to the air. Hydrocarbons are formed and released into the environment during incomplete combustion of e-waste materials such as coal, gas and oil. As a result, the quality of air is severely affected causing air pollution.

Open burning and incineration results in the generation of gases and the residue ashes

such as “bottom ash” from primary residues and “fly ash” from gas emissions. Bottom ash has been released into the land resulting in ground water pollution. Fly ash spreads through the air and causes air pollution, which leads to various types of environmental damage, which may lead to greenhouse gas emissions and acid rain.

The mercury released to the atmosphere can lead to bioaccumulation in food chains. It can reach dangerous levels of damage to humans and animals, even when released in minute quantities.

Water pollution

Besides air pollution, water also can be contaminated by e-waste. Most of the electronics are disposed of to landfills and after a period of time, the toxic substances leach into ground water. For instance, lead and other heavy metals leach from landfills into drinking water sources and nearby water bodies leading to severe water pollution.

According to the research done by Action Network in Linjaling River, Guiyu, Japan which has largest e-waste recycling industry shows that the content of lead in water is between 1.9-2.4 mg/L. It is much higher than the WHO guideline, which is only 0.01mg/L. As a result, drinking water in Guiyu is imported from nearby towns. Most ecologists predict that the same situation could arise on a global scale in the near future, if unmanaged e-waste is added to the environment as at present.

Soil pollution

Landfill disposal of e-waste is another popular method. But over time the chemicals infiltrate from the products and make their way into ground water and soil resulting in soil pollution.

This situation is confirmed by research conducted in 2010 that investigated the contamination of agricultural soil in Taizhou area, Japan. This research clearly shows a very high concentration of lead, zinc and chromium in agricultural soil near e-waste recycling workshops. The environments around the e-waste dumped sites are severely affected. . It creates mountains of e-waste and destroys the value of the land and soil. These kinds of soils and lands can support any kind of agricultural activities.

The outside of most electronics are made of a combination of plastic, glass, and sometimes, metal. However, they include heavy metals, chemicals and other potentially hazardous substances. Therefore e-waste materials alone do not simply end up in a landfill.

Soil and water pollution are a crucial source of food chain contamination. Some dangerous substances may accumulate in agricultural lands and be available for intake by grazing livestock. In addition, most chemicals may bio-accumulate in tissues of animals at a slow

[2] *The process of destroying e-waste equipment through burning is called incineration.*
[3] *Ash that is generated in primary residues is called bottom ash.*
[4] *Ash that is generated in flue gas emissions is called fly ash.*
[5] *The process of dangerous chemicals accumulated in living tissues in the human and animal body is called as bioaccumulation.*

metabolic rate and be excreted in edible products such as eggs and milk. Not only humans but also animals and plants are also affected by e-waste.

The main risk to human health and environment arises from inappropriate and unsafe management practices related to disposal and recycling of e-waste. Informal e-waste recycling allows the emission of dangerous chemicals to air, water and soil. The main risk to the environment arises from the metals and other potentially hazardous substances contained in e-waste. There are three main groups of substances that may be released during recycling. They are

- Original constitutions of equipment such as lead, mercury
- Substances that may be added during some recovery processes such as cyanide
- Substances may be formed by recycling processes such as dioxins.

Therefore if recycling procedures are not managed properly, these substances may pose serious environmental threats. It creates high risks to humans and animals today as well as to future generations living in the local environment.

The environmental impacts of processing e-waste components

E-waste component	Process used	Potential environmental hazards
Cathode ray tubes (used in TVs, computer monitors, ATM, video cameras, and more)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table -a thin plate on which chips and other electronic components are placed)	Removal of computer chips; open burning and acid baths to remove final metals after the chips are removed.	Air emissions as well as discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Hydrocarbons, heavy metals, brominated substances discharged directly into rivers acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominates dioxins, heavy metals and hydrocarbons
Plastics from printers, keyboards, monitors, etc.	Shredding and low temperature melting to be reused	Emissions of brominates dioxins, heavy metals and hydrocarbons
Computer wires	Open burning and stripping to remove copper	Hydrocarbon ashes released into air, water and soil.

2.4 Cultural impacts of e-waste

Human consumption of goods is obviously part of human culture. In the last two decades, the global consumption of electronic equipment has increased. As a result, a throw-away culture has been witnessed in the developed world. Consumers want the latest and best products and previous models are thrown away when a newer version is available in the market. Therefore, e-waste has become a major issue in the world.

It is hard to imagine life without electronic equipment. It is a characteristic that affects human life in every part of the world today. It also creates several new cultural patterns, trends and behaviors among consumers.

For example, in the United States (USA) consumers have developed a "must-have" culture. It is characterized by a desire for the newest and most advanced technologies. Many psychologists suggest that social phenomena such as the theory of "Informational Cascade" may govern the prevalence of consumer electronic fads.

In addition, e-waste has created a disposable culture. Consumers discard used products to get the newer version of the same product. Consumers trash their older models for newer versions without considering the global environmental and social impact of their action. Thus, in a broader sense, e-waste is a cultural dimension of human behaviour.

E-waste is extremely harmful to human health and has many devastating long-term effects. People living in e-waste recycling towns and workers in e-waste recycling plants face high risks to their lives. Especially it has serious adverse side effects on children. Children's bodies, minds and judgments develop based on their experiences of society and their brain functions are influenced by their experiences. Therefore association with e-waste creates dangerous cultural and ethical matters in the next generation. In order to ensure that people make positive choices about the environmental impacts on their life style, there is an urgent need to create mass scale awareness of the e-waste issue.

2.5 Social impacts of e-waste

The impact associated with electronic devices throughout their product life cycles is varied and complex. Nowadays consumers want the latest and best products, so people throw away previous products in a shorter time. This releases large amounts of e waste to the environment. Computers and mobile phones are a good example as the technology changes rapidly and older models cannot handle modern software. Every year the world produces 40 million tons of e-waste from TVs to refrigerators to cell phones and computers. These phenomena will only increase the adverse impact on society.

Example: By the 2020, China is expected to throw away seven times more cell phones than now, and India 18 times more.

Honorine, (2010)

As societies produce more and more electronic goods, more and more e-waste is released to the environment. E-waste affects human health in many different ways and can lead to infertility, respiratory illnesses and cancers.

2.6 The way forward

Management of e-waste has become a major challenge for producers, consumers, government and society as a whole. The problem today is compounded by the growing complexity of the trade. E-waste is produced by developed nations and then imported to poor countries as dumping yards. The impact of e-waste in poorer countries is more devastating than in developed countries as huge costs and effort are needed to minimize its adverse effects and to recycle e- waste.

Electronics clearly benefit our lives, especially in areas such as education, medicine and science. Therefore their negative impact needs to be minimized. This calls for research in areas such as computer science, mechanical engineering, materials science, environmental engineering and industrial design in order to obtain maximum benefit from electronics while minimizing their adverse effects.

Current Status of E-Waste

Chapter Three

3.1 Global status of e-waste

As highlighted in the previous chapter, e-waste is a global problem and a challenge to every country in the world. Globally, more than 50 million tons of e-waste was disposed of in 2009 and 72 million tons in 2014, while the global e-waste recycling rate is projected to increase from 13% to 18.4% between 2009 and 2014. It is estimated that 50% to 80% of e-waste from developed countries is exported to developing countries. While some governments are forbidding the export of e-waste to developing countries, exportation is on the rise due to economic incentives offered for informal recycling. Developed nations benefit from cheaper labor costs in developing nations, while the imported e-waste creates jobs for developing nations and provides second hand products for re-use.

Understanding the e-waste status and problems in Asia needs special attention in the global context as most of these e-waste recycling countries are in this continent.

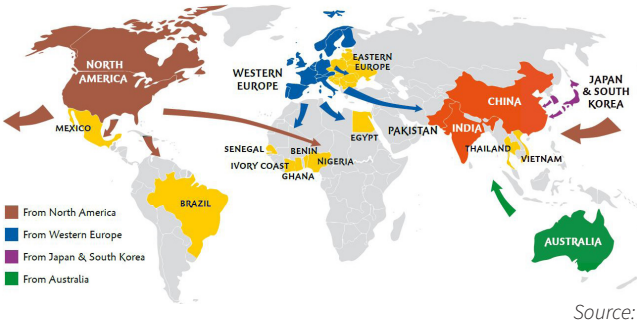
3.2 E-waste in Asia

Rapid industrialization and advances in technology have led to dangerous e-waste problems among many Asian countries. The developing countries in Asia will be producing at least twice as much e-waste as developed countries within the next 6-8 years, according to the United Nations University (UNU) (2010).

Asian countries can be divided into two groups, East Asian and South Asian. East Asian countries mainly include China, Japan and Korea. India, Pakistan, Bangladesh and Sri Lanka are some of the South Asian countries. According to the EPA (2014), East Asian countries are producing more e-waste than South Asian countries.

In addition to domestic generation, a significant amount of e-waste is imported into Asian countries legally or illegally for recycling. Approximately 80%- 90% of e-waste in the USA is exported to the Asian countries, mostly to China and India, as these Asian countries have comparative advantages in low cost recycling (UNU, 2010). The following map shows the flow of e-waste to Asian countries.

E-waste flows in the world



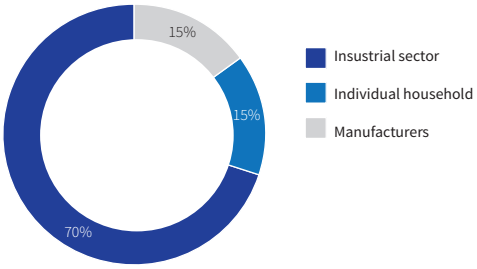
Source: Lundgren, (2012)

According to the EPA (2014), the Asia Pacific e-waste market was worth US $1.856 in 2012 and is expected to reach US $ 4.01 billion in 2017. In the context of the importance of e-waste management in Asia, the chapter first focuses on the current status of e-waste in three Asian countries -India, China and Japan.

E-waste in India

India is the second largest e-waste generator in Asia. The Indian e-waste industry is booming at a rapid rate. According to the Ministry of Environment & Forests of India (MoEFI) (2013) it is expected to increase at a rate of 20% annually. Also, India is one of the largest e-waste importing countries in the world.

Sources of e-waste in India

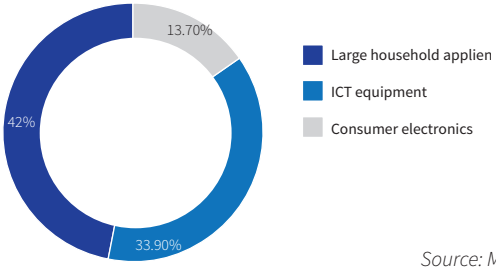


Source: MoEFI, (2013)

As depicted in the above figure the main sources of e-waste of India are government and private (industrial) sectors, which account for almost 70% of total e-waste generation. The contribution of individual households is relatively small and is about 15%, the rest being contributed by manufactures. It is reported that an average middle class family generates nearly 19kg of waste annually in India (MoEFI, 2013).

According to the Manufacturer's Association for Information Technology (MAIT), (2013), 90% of the total e-waste generation in India comprised three main categories as shown in the following chart.

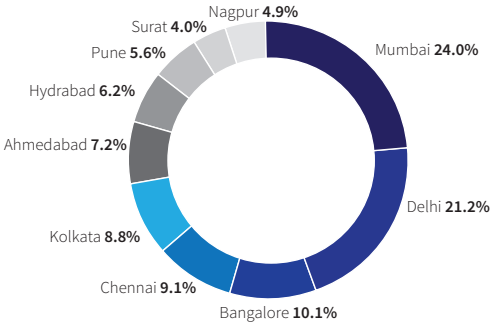
Categories of e-waste in India



Source: MAIT, (2013)

Based on the survey carried out by the Central Pollution Control Board (CPCB) (2013), there are 10 states that contribute to 70% of the total e-waste generated in the country. The top 10 cities and states with their percentages are shown in the following chart.

Major e-waste generating cities in India



Source: CPCB, (2013)

As there is no separate collection of e-waste in India, there is no clear data on the quantity generated or disposed of in each year.

According to the research conducted by the Pradhan (2013), e-waste generated in India for the year 2007 was 3, 32,979 MT (Metric tons). However, the total e-waste available in 2007 for recycling was 43 %.

India has mainly two types of e-waste markets -organized and unorganized. However, in order to recycle e-waste, India depends heavily on the unorganized sector. As per the EPA (2014), more than 90% of the e-waste generated in the country ends up in the unorganized market for recycling and disposal. Over 1 million poor people in India are involved in the manual recycling operation of e-waste.

Only 40% of the total e-waste generated in India is taken into the recycling processes. The rest 60% remains in warehouses due to inefficient and poor collection systems. There are

about 75 authorized and registered e-waste recyclers. However, many recyclers in India are carrying out their operations at under capacity.

TIO Group India (Pvt) Ltd has a capacity of 500 tons to process e-waste annually but processes only 200 tons per year. Attero Ltd can process 36,000 tons per year although it gets only 600 tons currently.

The Government of India has taken several initiatives to deal with the e-waste issue:

- Ministry of Environment and Forests, CPCB and State Pollution Control Board have been constituted to safeguard the environment and health of the general public.
- Indo- German- Swiss Partnership for e-waste has been working with the informal recycling sector to improve their techniques and processes and prepare them for a more formalized role.
- Community Lead Environment Action Network (CLEAN) has been conducting several projects to increase public awareness of e-waste.

Having looked at South Asia's largest economy, the chapter next focuses on the e-waste status of the Asia's largest economy, China.

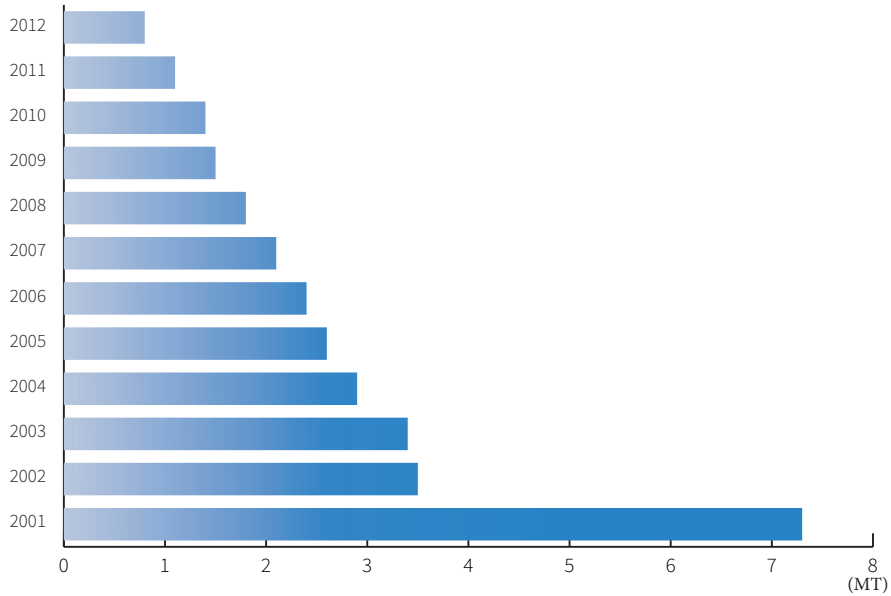
E-waste in China

China is one of the world's largest producers and exporter of electronic products as well as one of the largest importers of e-waste. China already produces around 2.3 million tons of e-waste domestically. Apart from domestic generation remarkable amounts of e-waste are imported into China for secondhand equipment.

As a result of increased worldwide consumption of electronic equipment, China is now facing serious e-waste problems. China is the world's second largest economy and has a 28.6% share of the global electrical and electronic equipment export market. According to the Wang et al. (2013), China contributes to 64% of total world's e-waste amount.

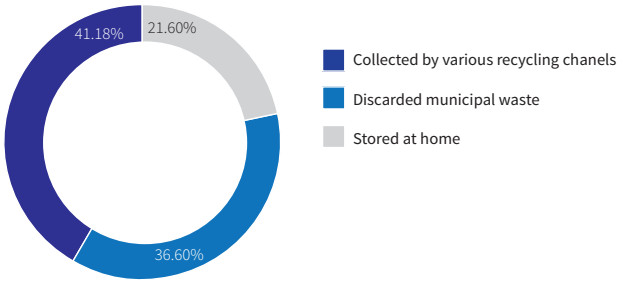
According to the Wang et al. (2013) China's daily e-waste output was 3,000 tons and 5.4 kg per capita in year 2012. This e-waste amount could rise by as much as 500% over the next decade. The following chart depicts the total e-waste generated in China.

Total e-waste in China (2012)



Source: Wang et al., (2013)

E-waste disposal behaviours in China



Source: Wang et al., (2013)

Both formal and informal sectors participate in the collection and recycling of e-waste in China. Currently more than 130 e-waste recycling enterprises are registered in China. According to the UNU Country Report (2010), the annual collection by formal sector is 64%. The formal sector collected and recycled a total of 61.3 million tons of e-waste in 2011. Nearly 60% of the e-waste was passed on to private collectors and transformed into informal recycling processes.

Guiyu, which is a town in Guangdong province in China, has been referred to as the "e-waste capital f the world". That is China's largest e-waste disassembly area. 85% of the town's 150,000 inhabitants are engaged in the business of dismantling e-waste. Guiyu is home to more than 300 companies and 3,000 individual workshops engaged in e-waste recycling.
Source: The Ministry of Industry and Information (MII), 2013

However the Chinese recycling market value declined from $ 107.5 billion in 2012 to $ 102.8 billion in 2013 due to the increase in invisible flows such as e-waste arising from the used good market and illegal dumping channels, etc. This market is expected to grow to nearly $ 156 billion in 2018 at a compound annual growth rate of 8.7%.

The Government of China has taken several initiatives on the e-waste issue as follows:

- "Development of a Public Private Partnership for e-waste Collection" project in cooperation with UNU and StEP.
- The project's primary activities included:
  - Promotion of the multi-party agreement among stakeholders.
  - Improvement of information exchange
  - Monitoring the collection and practices of e-waste under the partnership
- Waste Household Electrical Device Collection, Utilization and Management Law. (Distributors are responsible for collecting e-waste and a special national funding was launched for recycling)

Having considered the Asia's largest economy this section next looks at Asia's most technologically advanced economy, Japan.

E-waste in Japan

According to Pariatamby and Victor (2013), total e-waste generated in Japan in 2005 was 860,000 tons (6.7 kg per capita). This amount has increased rapidly and the total e-waste generated in 2012 was 2.7 million metric tons (21.5kg per capita).

The recycling rate in Japan has also increased rapidly. According to the Organization for Economic Co-Operation and Development (2010), the recycling rate in Japan increased from 8% in 1990 to 14% in 2010. The Government of Japan, however, planned to raise the recycling rate from 20% in 2013 to 25% in 2017.

Japan has a well-developed recycling industry that consists of both formal and informal recyclers. More than 400 e-waste collection points facilitate to the collection of e-waste. The collected e-waste is transported to the intermediates and finally to the recyclers.

The Government of Japan has taken several initiatives:

- The Law for the Promotion of Effective Utilization of Resources (LPUR) encourages manufacturers to voluntarily help recycling and reduce the generation of e-waste.
- Conducting several programs to promote environmentally sound e-waste system based on the 3R approach (Reduce, Recycle, Re-use)

– Home Appliance Recycling Law (HAPL) imposes an "old for new requirement" system, where Japanese retailers are required to take back the used products from the consumer each time they sell a new product.

This chapter next focuses on the USA, the world's largest economy.

3.3 E-waste in the USA

The USA generates about 258.2 million units of used computers, monitors, TVs and cell phones per year, 171.4 million of which was collected for recycling, and 14.4 million was exported, according to a report issued by (EPA, 2013a). These figures reveal that the U.S. is a major exporter of used electronics. The USA exports more CRT (cathode ray tube) monitors by weight than any other product, and more cell phones than any other electronics product in terms of numbers.

According to the EPA (2013a) during the year 2011, more than 34 million TVs, 24 million PCs, and 139 million portable communication devices – including mobile phones were produced and sold in the USA. The following table shows the number of different e- waste items disposed of in 2010.

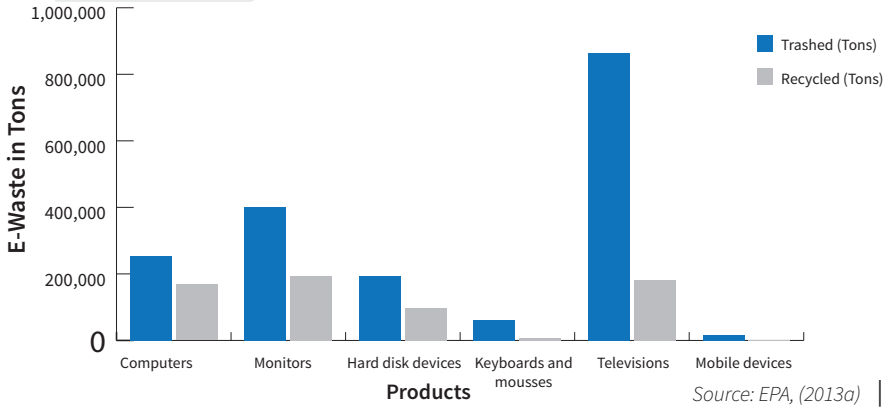
E-waste in USA (2010) -trashed vs. recycled

Products	Trashed (Tons)	Recycled (Tons)
Computers	255,000	168,000
Monitors	401,000	194,000
Hard disk devices	193,000	97,000
Keyboards and mousses	61,400	6,460
Televisions	864,000	181,000
Mobile devices	17,200	2,240

Source: EPA, (2013a)

The following chart shows the e-waste disposed in 2010:

E-waste disposal in USA (2010)



Source: EPA, (2013a)

It is clear that e-waste has become a major issue in the USA, the gravity of which has prompted the Government of the USA to take several initiatives:

– 'National Strategy for Electronics Stewardship' - This is a strategy for responsible electronic design, purchasing, management and recycling. Through this strategy, the government hopes to achieve four targets:
  - ⇨ Promote the development of more efficient and sustainable electronic products,
  - ⇨ Direct Federal Agencies to buy, use, reuse and recycle their electronics responsibly,
  - ⇨ Support recycling options and systems for American consumers, and
  - ⇨ Strengthen America's role in the international electronics stewardship arena.

– Solving the E-waste Problem (StEP) Initiative

The United Nation's Solving the E-waste Problem (StEP) Initiative, founded in 2007, is a global consortium of companies, research institutes, government agencies, international organizations and NGOs dedicated to the management and development of environmentally, economically and ethically sound e-waste resource recovery, reuse and prevention. The StEP Initiative does not endorse any specific products and seeks instead to provide science-based but applied recommendations towards a sustainable solution to the e-waste issue. There are five task forces of StEP: policy, redesign, reuse, recycle and capacity building. All of these task forces focus on globally accepted practices, principles and standards.

The analysis of global statistics and current e-waste management in most of the developed countries reveals the following:

- ⇨ Many western countries export their e-waste to Asian countries, the main reason for which is the low cost of labor and accessibility to informal recycling methods.
- ⇨ The Governments of European countries and the USA have taken the e-waste issue more seriously compared to Asian countries. As a result, many organizations have introduced relevant policies and programs to minimize the dangers of e-waste.

Regulatory Aspects of E-Waste

Chapter Four

4.1 E-waste in a global context

Due to the rapid advances in technology, the life cycle of electronic products has been reduced significantly. This results in increasing the number of obsolete products that cause environmental concerns due to the rapid depletion of the e-waste disposal capacity.

Substantial amounts of electronic waste (e-waste) are generated in the developing countries. These e-wastes are not collected for proper disposal in most developing countries. They are very often used in landfills, repaired and re-used or subjected to open burning. which are considered as low-end management alternatives while sound waste management practices such as repair and manufacturing, recycling and incineration are ignored owing to low profitability.

Most countries in Europe and North America already have specific expertise in waste management, which can be used and shared to optimize learning and to maximize efficiency in implementing improvements in e-waste management. For effective management of e-waste in developing countries, there is an urgent need to implement legislation dealing specifically with e-waste and appropriate landfill technologies for toxic wastes arising from waste management activities.

In the matter of the problems of e-waste, the United Nations entered into important international conventions relevant to the disposal, import and export of chemicals, pesticides and waste management. The main objective of these conventions is to protect human health and the environment from chemicals and pesticides. These conventions, namely the Basel, Rotterdam and Stockholm Conventions, are followed globally. Most of the countries have implemented policies and procedures with regard to chemicals, pesticides and waste management based on these conventions.

4.2 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, Switzerland.

The Basel Convention is an international treaty designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed countries to less developed countries (LDCs).

The Convention came into force on 5 May 1992. As of February 2014, 181 states and the European Union are parties to the Convention. Haiti and the United States have signed the Convention but not ratified it.

Background and objective

The Convention came into force on 5 May 1992. As of February 2014, 181 states and the European Union are parties to the Convention. Haiti and the United States have signed the Convention but not ratified it.

Awakening environmental awareness and tightening of environmental regulations in the industrialized world led to increasing public objection to the disposal of hazardous wastes and to a growth of disposal costs. Some companies sought cheap disposal options for hazardous wastes in Eastern European and the developing countries, which have less environmental awareness and regulations and where enforcement mechanisms are weakly operated. The Basel Convention was negotiated in the late 1980s against this background and it made a push at the time of its adoption to combat the "toxic trade".

The objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" and two types of wastes defined as "other wastes" such as household waste and incinerator ash. The Convention covers hazardous wastes that are explosive, flammable, poisonous, infectious, corrosive, toxic, or eco-toxic.

There are several objectives of the Convention:
- The reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes.
- The restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management.
- A regulatory system applying to cases where transboundary movements are permissible.

In addition to conditions on the import and export of the hazardous wastes, there are strict requirements for notice, consent and tracking for movement of wastes across national boundaries. The Convention places a general prohibition on the exportation or importation of wastes between Parties and non-Parties.

After the initial adoption of the Convention, some least developed countries and environmental organizations argued that it did not go far enough. Many nations and NGOs argued for a total ban on shipment of all hazardous waste to less developed countries. In particular, the original Convention did not prohibit waste exports to any location except Antarctica but merely required a notification and consent system known as "Prior Informed Consent" or PIC, which requires that, before an export may take place, the authorities of the State of export notify the authorities of the prospective States of import and transit, providing them with detailed information on the intended movement. The movement may only proceed if and when all States concerned have given their written consent.

Further, many waste traders sought to exploit the good name of recycling and began to justify all exports as moving to recycling destinations. Many believed a full ban was needed including on exports for recycling. These concerns led to several regional waste trade bans, including the Bamako Convention.

The 1995 Basel Conference of LDCs and several European countries such as Denmark led to the adoption of an amendment termed the Basel Ban Amendment to the Basel Convention. The Amendment prohibits the export of hazardous waste from a list of developed countries to developing countries. The Basel Ban applies to the export for any reason, including recycling. The European Union fully implemented the Basel Ban in its Waste Shipment Regulation (EWSR), making it legally binding in all EU member states.

The Basel Convention also provides for cooperation between parties, ranging from exchange of information on issues relevant to the implementation of the Convention to technical assistance, particularly to developing countries (Articles 10 and 13).

The Convention also provides for the establishment of regional or sub-regional centers for training and technology transfers regarding the management of hazardous wastes and other wastes and the minimization of their generation to cater to the specific needs of different regions and sub regions (Article 14).

Sri Lankan status

Sri Lanka ratified the Basel Convention in 1992 and a Cabinet decision was obtained to prohibit the import of hazardous waste from all countries for final disposal or for recovery. The Department of Export and Import Control is in the process of drafting regulations under the directions of the National Coordinating Committee.

Sri Lanka has no restrictions on the export of hazardous wastes and other wastes for final disposal or for recovery. However, the export of hazardous waste will be carried out only under the provisions provided under the Basel Convention.

Sri Lanka restricts the transit of hazardous wastes and other wastes. The controlling procedures are in accordance with the provisions of the Basel Convention.

Sri Lanka does not manufacture chemicals and almost all the chemicals used are imported. This convention requires the owner, the receiver and the transporter of any chemical, which could be toxic, poisonous, hazardous or eco toxic to get a clearance from the relevant authority in charge of Basal Convention.

A guidance manual for safe and effective detection and investigation of illegal traffic and transboundary movement of hazardous wastes and other wastes has been prepared.

The Environmental Protection License scheme and the Environmental Impact Assessment scheme under the National Environmental Act are in place.

Guidelines for locating industries have been formulated. Regulations for hazardous waste management have been prepared and will be gazetted shortly.

At present there are no authorized organizations for the disposal of hazardous waste. But negotiations are being conducted. However, Cabinet approval has been granted to seek private sector partnerships in management of hazardous waste in Sri Lanka. Preliminary arrangements are being carried out to establish a hazardous waste management facility in Sri Lanka. Industrialists treat their own waste under the Environmental Protection License. On the other hand, industrialists are compelled to operate their own waste treatment plants.

4.3 The Rotterdam Convention

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade is both a United Nations treaty and a multilateral treaty. The Rotterdam Convention was adopted on 10 September 1998 by the Conference of Plenipotentiaries in Rotterdam, the Netherlands. The Convention came into force on 24 February 2004.

The objectives of the Convention are:

- to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment, and
- to contribute to the environmentally sound use of those hazardous chemicals by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties. Old electronic equipment and equipment containing hazardous substances are still being exported, which harm workers at recycling plants. This convention helps to control the import and export of such electronic equipment which contain hazardous chemicals and pesticides.

The Convention helps developing countries to use the infrastructure to report problems with hazardous pesticide formulations. Even though pesticide poisoning is a severe problem in the world, only few developing countries have been able to use the opportunity provided in the Rotterdam Convention. Therefore, to assist countries in better monitoring pesticide poisonings and better reporting, two years ago the Secretariat of the Rotterdam Convention started collecting data.

Sri Lankan status

Before all other Asian countries, Sri Lanka has been able to benefit from this convention. The Rotterdam Convention was ratified by Sri Lanka on 19 January 2006. The Ministry of Agriculture is responsible for activities related to pesticides while industrial chemicals related activities are controlled by the Ministry of Environment. The Pesticide Registration Office and the Central Environmental Authority are the appointed national authorities for pesticide and industrial chemicals such as Actinolite asbestos, Anthophyllite and Amosite asbestos respectively.

4.4 The Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants was adopted by the Conference of Plenipotentiaries on 22 May 2001 in Stockholm, Sweden. The Convention came into force on 17 May 2004 with ratification by 128 parties and 151 signatories.

The Stockholm Convention is a global treaty designed to protect human health and the environment from chemicals that remain intact in the environment for long periods of time and are widely distributed geographically. Since these chemicals accumulate in the fatty tissue of humans and wildlife, chemicals can create harmful implications on human health and on the environment.

Exposure to Persistent Organic Pollutants (POPs) can lead to serious health effects including cancers, birth defects, allergies and hypersensitivity, dysfunctional immune and reproductive systems, greater susceptibility to disease and damage to the central and peripheral nervous systems.

In order to find solutions for this emerging global issue, the Stockholm Convention requires its members to take measures to eliminate or reduce the release of POPs into the environment as much as possible.

Objective

The main objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants and eliminate the 12 POPs of global concern.

Main provisions

The main provisions of the Convention include the requirement for developed countries to provide new and additional financial resources and measures to eliminate the production and use of intentionally produced POPs, eliminate unintentionally produced POPs where feasible, and manage and dispose of POPs wastes in an environmentally sound manner.

This provision requires each party to,

- Prohibit, eliminate the production and use and import and export of the intentionally produced POPs.
- Reduce or eliminate releases from unintentionally produced POPs.
- Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner.

Intentionally Produced POPs

The Convention requires Parties to eliminate or restrict the production and use of the intentionally produced POPs. The Convention also establishes a public DDT (Dichloro Diphenyl Trichloroethane) registry of users and producers, and it encourages the development of safe, effective, affordable, and environmentally friendly alternatives.

The Convention prohibits trade in POPs chemicals for which Parties have eliminated

production and use. Such POPs may be exported only for environmentally sound disposal.

The Convention also allows Parties to register for specific exemptions on a country-by-country basis. These exemptions are subject to review and expire after 5 years, unless extended by the Conference of Parties (COP).

The Conference of the Parties (COP)

The Conference of the Parties (COP) was established pursuant to Article 19 of the Convention. It is the governing body of the Stockholm Convention and is composed of governments of countries that have accepted, ratified or acceded to it. The implementation of the Convention is done through the decisions taken at its meetings.

Sri Lankan status

Sri Lanka became a signatory to the Stockholm Convention on POPs on 5 September, 2001 and ratified the Convention on 22 December, 2005.

In order to meet the obligations towards the Convention, the Government of Sri Lanka initiated activities to prepare the National Implementation Plan (NIP) for the control of POPs with the assistance of the United Nations Environment Programme and Global Environmental Facility (UNEP/GEF).

The project for the formulation of the NIP was planned so as to satisfactory execution of the following activities:

- Establishment of a coordinating mechanism,
- Formulation of POPs inventories and assessment of infrastructure and capacities,
- Priority setting and determination of objectives,
- Formulation of the NIP, and
- Endorsement of the NIP by the stakeholders.

Sri Lanka has been fortunate that the detrimental effects of POPs had been noted long before the Stockholm Convention came into force and had never manufactured any of the POPs chemicals.

Sri Lanka has the following legal provisions that regulate POPs. Some of them are general environmental provisions and are not directly related to POPs.

- Constitutional provisions
- National Environmental Act
- Control of Pesticide Act

Like other developing countries in Asia and Africa, Sri Lanka is now confronted with the huge problem of e-waste both locally generated and internationally imported. Trading of used electronic items has become a common practice and the number of sales centres had increased notably within past decade.

Almost all the computers and their parts are imported. Therefore, there is a tendency to spread low cost versions and second hand computers and related units with a very

short life span making use of the fact of need vs. ability to pay. It is necessary to promote sustainable purchasing systems to prevent and minimize the generation of e-waste. This is true also for mobile phones and other consumable items such as washing machines.

Re-entering the market to service the needs of those who cannot afford brand new ones, mobile phones are entering the market without getting exactly accounted. A recent study has revealed that the penetration rate of mobile phones will reach 40% in 2009 as against the present penetration rate of 28%. The annual growth rate estimated for the other major e-items include Personal Computers 8-10%, Printers 5-7%, Televisions 6-8%, Refrigerators 4-6%, Air-Conditioners 4-6%, Photocopying Machines 2-4%, Washing Machines 6-8% and Batteries 4-6%.

Many unusable computers and other e-equipment are stored at various institutions and currently disposed of in a haphazard manner in roadside dump yards and sometimes in home gardens without proper disposal systems. These e-items contain hazardous materials such as lead, cadmium, chromium and mercury which need proper attention to prevent mixing with municipal waste in the landfill sites.

Currently Sri Lanka does not have a comprehensive e-waste recycling facility. Hence government encourages exportation of e-waste for recycling by fulfilling the country's regulatory requirements as well as international obligations on Transboundary movements of Hazardous Waste and other international laws (e.g. Basel Conventions Transboundary Movement Procedure).Currently there are few such exporters operating their e-waste management facilities within the country and their operations are being monitored by the CEA in regular basis.

As per a cabinet decision taken in 1998 Sri Lanka banned the importation of List A waste of Schedule VIII of the Basel Convention and List B importations are regulated on a case-by-case basis. Even though used computers are listed under List B it is not properly controlled when importing because of the lack of a gazetted regulation on this cabinet decision. However, currently CEA is considering the banning of importation of used CRTs considering the difficulty in channeling them for recycling.

As Sri Lanka is embarking on an e-society development initiative with the full support of the Government, there will be a high demand for e-items in the near future. This situation will generate higher amounts of e-wastes if proper policies and strategies are not in place to address this issue. This e-waste policy is a timely action that has to be taken in managing electrical and electronic equipment in a manner which is sustainable throughout its life cycle. It is also necessary to honor and comply with the provisions of the Basel Convention and other related Conventions ratified by the country for managing e-waste.

4.5 Country specific legal aspects of e-waste management

Owing to the Conventions mentioned in the previous section and for various other reasons, many countries have specific legislations pertaining to the management of e-waste. This section of the chapter focuses on the legal aspects of e-waste management in both developed and developing countries. The United States of America, the United Kingdom, Japan and Germany are selected as developed countries while India, China, Pakistan and Bangladesh are selected as developing countries.

The United States of America (US)

With respect to e-waste the US has many legislations such as National Television and Computer Recycling Act, Resource Conservation and Recovery Act, Responsible Electronics Recycling Act, Electronic Waste Recycling Promotion and Consumer Protection Act, etc. Some of these prominent legislations in the US are described below:

National Television and Computer Recycling Act of (2007)
This Act has been enacted to encourage and promote the recycling of used computers and TVs, printers and computer products.

Under this law, households and small businesses can drop-off these items for free at designated access points, which may include permanent collection sites, take-back events or through a mail-back option. Accepted items include TVs and computers and computer products including monitors, laptops/notebooks, printers/scanners, keyboards, mice and hard drives.

Resource Conservation and Recovery Act (RCRA) of 1976

The Act covers the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes. The objectives of this Act are to: protect human health and the environment from the potential hazards of waste disposal, conserve energy and natural resources, reduce the amount of waste generated, and ensure that wastes are managed in an environmentally sound manner.

To achieve these goals RCRA established three interrelated programs:

- Solid waste program,
- Hazardous waste program, and
- Underground Storage Tank (UST) program

Some electronics such as color CRT computer monitors, color CRT TV tubes, and smaller items such as cell phones and other hand-held items, which are subject to special handling requirements under Federal Law, are subjected to certain exemptions under this Act.

The Act encourages reuse and recycling of used electronics, including those that test hazardous. To facilitate more reuse and recycling of these products, RCRA imposes less stringent management requirements for products bound for reuse and recycling.

Computer monitors and TVs sent for continued use (resale or donation) are not considered as hazardous wastes. Circuit boards are subject to a special exemption from Federal Hazardous Waste Rules.

The United Kingdom (UK)

There are many Acts in the UK that either directly deal with e-waste or have some implications for e-waste management. As the UK is a member state of the European Union, the legislations in the Union are also applicable. Some of these legislations include Environmental Protection Act, Environment Act, National Policy Statement on Hazardous Waste, Transfrontier Shipment of Waste Regulations, Hazardous Waste (England and Wales) Regulations, WEEE (Waste Electrical and Electronic Equipment) Directive, European Waste Framework Directive, etc. The next sections of this chapter briefly describes some of these salient legislations.

European Waste Framework Directive of 2008

This Directive provides the legislative framework for the collection, transport, recovery and disposal of e-waste, and includes a common definition of e-waste. The Directive requires member states to take appropriate measures to encourage, firstly, the prevention or reduction of e-waste production and its harmfulness, and secondly, the recovery of waste by means of recycling, re-use or reclamation or the use of e-waste as a source of energy. The Directive requires additional record keeping, monitoring and control obligations when managing hazardous waste over non-hazardous waste.

Under this Directive, exemptions that may be granted for installations dealing with hazardous e-wastes are more restrictive than for installations dealing with other wastes. The Directive also requires arrangements to be made by way of separate collection of waste (The Waste-England and Wales- Regulations, 2012). Collected E-waste should be disposed of without damaging human health and harming the environment.

WEEE (Waste Electrical and Electronic Equipment) Directive of 2012

This Directive is the EU's primary driver to achieve a higher level of environmental protection and encourage resource efficiency. It sets targets for the collection, reuse and recycling of e-waste.

The WEEE Directive also places responsibilities on householders, retailers, business users and local authorities on the movement, management, recovery and disposal of e-waste.

Hazardous Waste (England and Wales) Regulations of 2005 No. 894

These Regulations address the disposal of waste that contains hazardous properties that could be harmful to human health or the environment. Amendments to these Regulations in April 2009 require strict controls from the point of its production to its movement, management, and recovery or disposal of e-waste.

Transfrontier Shipment of Waste Regulations of 2007

The Transfrontier Shipment of Waste Regulations have been implemented to control the movement of waste (including recyclable materials) between countries. These Regulations

require auditable trails of all e-waste materials being exported, imported and moved across country borders and further provision for the control of the importation, exportation, use, supply or storage of e-waste

Japan

Basic Law for the Recycling-based Society of 2000

In 2000, with the purpose of establishing a recycling-based society, Japanese government passed the 'Basic Law for the Recycling-Based Society'.
Under this Law, Japan plans to reduce the production of waste including e-waste, use produced e-wastes as resources and properly dispose of wastes that cannot be used by any means.

Accordingly, seven other laws including the Electric Household Appliance Recycling Law have been integrated to establish a recycling-based society in Japan. The Electric Household Appliance Recycling Law was made obligatory for business parties that produce / sell electric household appliances.

Law for the Effective Utilization of Resources of 1991

This Law provides recycling requirements for a wide range of products that include personal computers (PCs) also. Due to the growing PC use in Japan this Law requires that businesses and households recycle all their discarded PCs.

The Home Appliance Recycling Law of 2001

This Law requires manufacturers and importers to collect and recycle products such as air conditioners, refrigerators, TVs and washing machines with obligation to finance the recycling of their own products. The Law also permits manufacturers to contract a trade group such as the Association for Electric Home Appliances (AEHA) to collect items on their behalf or use the services provided by a local government. After the collection, the materials are required to be transported to consolidation centres operated by major manufacturing companies. Each centre provides recycling facilities around Japan.

Germany

Until 2005 no e-waste specific legislation was in place in Germany. Until the reunification of West Germany and East Germany, each of the German states had its own legislation for waste management. Starting with the reunification in 1990, the West-German legislations including on waste management were gradually transferred to the territory of the former East Germany.

Waste Management Act of 1972 and 1986

Waste management including e-waste is the responsibility of the municipalities in Germany. The main objective of this Act (passed in 1972) was to stop the uncontrolled e-waste dumping in the German municipalities and districts. The Act was designed as a regulation for organizing and planning the disposal of wastes including e-waste. It clearly regulates the responsibilities for waste management, and consequently, the number of landfills was reduced.

In 1986, the Federal Act on Prevention and Disposal of Wastes was enacted, which has guidelines for the prevention, treatment and recycling and reduction of wastes including e-wastes.

Substance Cycle and Waste Management Act of 1994

According to this Act, the municipalities are held responsible for environment-friendly treatment and disposal of e-waste once collected from consumers. Depending on the municipalities, e-waste can be handed over to private treatment operators or the municipalities themselves conduct the treatment fully or partially.

As per this Act, private consumers generally have to pay fees at the municipal collection point when handing in e-waste, at least for those types of equipment where the sales of the recycled materials could not cover the cost of treatment and disposal.

India

There are no specific environmental laws for the management and disposal of e-waste in India. However, the Municipal Solid Waste Rules, which regulate the disposal of municipal solid wastes, and the Hazardous Waste Rules, which define and regulate all aspects of the hazardous waste, have some relevance to e-waste management.

The Hazardous Waste (Management and Handling) Rules of 2008

Import and export of e-waste are regulated under these Rules and no permission for import of e-waste has been granted during the past years by the Ministry of Environment and Forests. However, permission for export of e-waste has been granted to various countries such as Belgium, Germany, Japan, Singapore, Hong Kong, Sweden, UK and Switzerland.

Guidelines for Environmentally Sound Management of E-waste of 2008

These Guidelines have been formulated with the objective of providing broad guidance for the identification of various sources of e-waste and the approach and methodology for handling and disposal of e-waste in an environmentally sound manner.

The Guidelines also emphasize the concept of Extended Producer Responsibility (EPR), a concept on which the Western countries base their disposal practices.

The E-waste (Management and Handling) Rules of 2010

The objective of these Rules is to enable the public to recover and/or reuse useful material from e-waste and thereby reduce the hazardous wastes destined for disposal, and to ensure environmentally sound management of all types of e-waste. These Rules provide for mandatory authorization of producer, collection centre, dismantler and recycler of e-waste.

China

The Chinese government undertook a number of measures to manage e-waste that include prohibition of import of e-waste and other hazardous waste since 2000 and implementation of the Technical Policy on Pollution Prevention and Control of Waste Electrical and Electronic Products (2006) and the Administrative Measures for the Prevention and Control of Environmental Pollution by E-Waste (2007). Also recently, China introduced a licensing scheme for proper e-waste recycling and consequently prohibiting informal recycling by unauthorized recycling firms.

The key national legislation and policies related to e-waste management in China are listed below:

Catalogue for Managing the Import of Wastes of 2000

This Catalogue includes second-hand electronic equipment and e-waste in the "List of Prohibited Goods to be imported for Processing or Trade", which is updated regularly.

The Technical Policy on Pollution Prevention and Control of WEEE of 2006

This Technical Policy aims to reduce the overall volume of e-waste, to increase the reutilization rate for discarded electrical and electronic equipment and to increase standards for e-waste recycling. It sets forth the overall guiding principles of "reduce, re-use and recycle" (3R). It provides a list of environmental measures to minimize environmental pollution during storage, re-use, recycling and final disposal of e-waste.

The Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products of 2007

This Ordinance was implemented with the dual goals of reducing the use of hazardous and toxic substances in electronic appliances, and reducing the pollution generated in the manufacture, recycling and disposal of these products. It provides restrictions on the use of six hazardous substances (lead, mercury, cadmium, chromium, and polybrominated biphenyl or polybrominated diphenylethers) in electronic products, and requires producers to provide information on the components and hazardous substances present in their products, as well as the period of safe use and the potential for recycling.

Administrative Measures on Pollution Prevention of Waste Electrical and Electronic Equipment of 2008

These Administrative Measures were enacted with the goal of preventing pollution caused by storage, transport, disassembly, recycling and disposal of e-waste. This policy applies to e-waste recycling companies seeking treatment licences once it has been confirmed by local environmental departments that the company has complied with treatment standards and requirements.

Pakistan

It is not legal under the Basel Convention – to which Pakistan is a party – to import e-waste into the country, and legislation is in place to manage e-waste in Pakistan. Some of these laws are explained next.

Environment Protection Act of 1997

This Act focuses on the protection, conservation, rehabilitation and improvement of the environment by preventing and controlling pollution.

Sections 13 & 14 of this Act directly deal with the import and export of e-waste. As per Section 13 of this Act "no person is entitled to import hazardous waste (that includes e-waste) into Pakistan and its territorial waters. Section 14 of the Act stipulates that no person can generate, collect, consign, transport, treat, dispose of, store, handle or import any hazardous substance including e-waste.

Environment Policy of Pakistan of 2005

In Pakistan this Policy is an overarching framework for addressing all sectors of the environment at national level. It also gives directions for addressing the cross-sectorial issues as well as underlying causes of environmental degradation and meeting international obligations. Under this Act the Government of Pakistan expects to reduce the importation of electronic equipment by imposing a 25 percent tax on computer screens.

There are some supportive institutions, some of which are:

- National Technical Advisory Committee on Chemicals (NTACC) -established to review and evaluate concerns of industrial chemicals and waste to take appropriate decisions.
- Ministry of Commerce and Federal Board of Revenue (FBR) -aimed to manage import / export control system related to different chemicals and waste.
- National Disaster Management Authority (NDMA) -established for emergency coordination in case of a chemical disaster in the country.

Unfortunately, these laws are not well enforced and there is no proper system to recycle and dispose e-waste in Pakistan. In Pakistan, computers and other obsolete electronic goods are imported under the pretext of 'second-hand equipment'. A small percentage of the items imported are usable. In practice, after removing the working machines and usable parts, the bulk of the consignment is sent to the recycling industry.

Hence, there are serious challenges which Pakistan faces relating to e-waste. The main challenge is inadequate regulatory measures, inadequate strategies and weak implementation of the law.

Bangladesh

The National Environmental Policy of 1992, highlighting the regulation of all activities that pollute and destroy the environment, and the subsequent Environment Conservation Act (ECA) of 1995 were established to conserve and enhance the quality of the environment and to control, prevent and mitigate pollution in Bangladesh.

The subsequent rules under the ECA, the Environment Conservation Rules of 1997, divide industries and projects into different categories depending on the pollution load and likely impact on the environment. There are some provisions and mandatory rules for building a waste management system within the industry sectors. However, e waste does not require any compliance under this Act or Rules.

The government is now preparing a solid waste management policy which may cover e waste. At the same time, the Medical Waste Management Rules of 2008 address waste management issues for the medical sector, including e waste.

The Government of Bangladesh has already prepared a draft National 3R (reduce, reuse recycle) Strategy which addresses e-waste issues.

Sri Lanka

Sri Lanka has many laws/policies that deal with e-waste. They include

- National Environmental (Protection & Quality) Regulations
- National Electrical and Electronic Waste Management Policy

National Environmental (Protection & Quality) Regulation No. 01 of 2008

As per these Regulations the following types of e-waste have been prescribed as hazardous waste that requires a license for handling.

- Mercury wastes
  - Discarded, used, fused, and broken fluorescent lamps/bulbs
- Waste electrical and electronic equipments
  - Discarded computers and accessories
  - Discarded mobile phones
- Waste from specific sources
  - Discarded batteries containing lead, mercury, nickel, cadmium, lithium and electrolyte from batteries and accumulators.

According to these Regulations a generator, collector, store, recycler, recoverer or disposer should obtain a Scheduled Waste Management (SWM Licence) from the CEA.

Some private and public institutions consider the SWM License as a primary requirement when they call tenders to hand over their obsolete e-waste items. This has induced the informal sector to apply for the licence.

National Electrical and Electronic Waste Management Policy in Sri Lanka of 2008

The Ministry of Environment and Natural Resources has prepared this Policy in consultation with the relevant government agencies, academics, environmental experts and the private sector.

The objectives of this Policy are as follows:

- Prevent/minimize negative impacts to environment and health due to haphazard use and disposal of e-products,

- Promote integrated e-waste management,
- Secure social responsibility towards sustainable production and consumption of e-products, and
- Ensure waste treatment and final disposal of e-waste in an environmentally sound manner.

The Policy covers areas such as

- Import and export of e-waste,
- Waste minimization (prevention, reuse, recovery and recycling),
- Waste collection, storage, transportation, treatment and disposal,
- Capacity building and awareness,
- Implementation and coordination mechanism, and
- Resource mobilization.

4.6 Legal aspects of e-waste: developed vs. developing countries

By examining the legal aspects and many other practices of both developed and developing countries the following observations can be made.

- Developed countries identified e-waste as a threat to the environment as well as human beings a few decades ago and have implemented necessary regulations and set up institutions to control and recycle e-waste, which are in force effectively.
- But developing countries have identified e-waste as a threat only recently and the implementation of rules, regulations, etc. is still at a low level.
- Developed countries have better expertise and technology to control and manage e-waste than developing countries. Although developing countries are parties to international conventions, lack of sufficient technical know-how is a major issue.
- Developing countries generally do not have control mechanisms on importation of e-waste or used electronic items.

Chapter Five

E-Waste Management in Sri Lanka

5.1 E-waste management

Proper e-waste management is of vital importance for the following reasons:

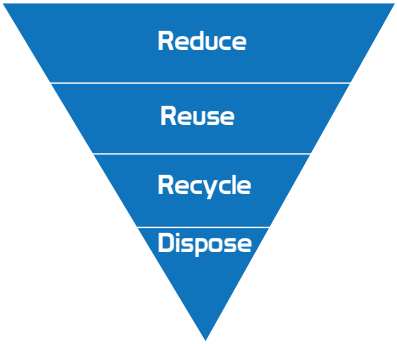
- E-waste resulting from the widespread use of electronic equipment causes environmental pollution.
- Precious metals like gold and silver are lost when electronic items are disposed of.
- Careless dumping of e-waste such as batteries which contain harmful chemicals like mercury can damage not only the environment but also the health of humans who live in close proximity to landfills.
- The poisonous effects of e-waste can cause serious and adverse impact on the environment which can in turn endanger human life.
- Valuable and confidential data can be stored in e-waste items such as computers and mobile devices.

The aforementioned reasons necessitate the proper management of e-waste.

5.2 E-waste management options

The main e-waste management options include reducing, reusing, recycling and disposal as shown in the following figure.

E-waste management hierarchy



Among these e-waste management options, recycling of e-waste offers many economic, environmental and social benefits. A few years ago, e-waste recycling was not an easy task. But today, consumers have many options to recycle or donate for reuse their used electronic equipment. E-waste recycling is explained in detail below.

5.3 Recycling of e-waste

E-waste recycling is the systematic process of collecting, sorting, dismantling and processing of e-waste. E-waste recycling is becoming ever more important in an era when the consumption of electronic products has grown substantially as the quality of life improves. Everyday new electronic devices and gadgets are introduced to the market due to rapid technological developments. Consequently, consumers tend to discard their old equipment that contains valuable materials, even though they are in good working condition.

Benefits of recycling e-waste

- Creates jobs opportunities,
- Prevents health problems,
- Reduces greenhouse- gas emissions,
- Reduces the risk of leakage of valuable data stored in devices,
- Conserves natural resources, and
- Provides useful raw material inputs for manufacturing other products.

5.3.1 General process of e-waste recycling

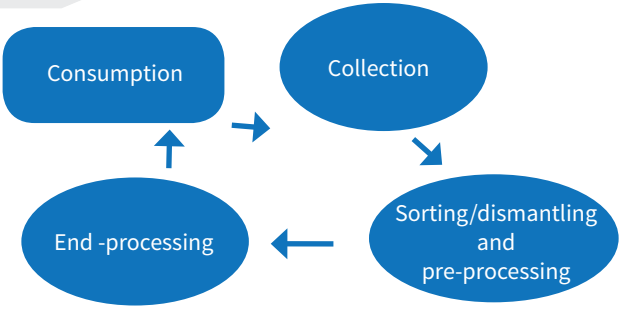
As explained in Chapter 2, most of the global e-waste is sent to developing countries. In Sri Lanka, the private sector and CEA collect e-waste using different methods such as establishing collecting centers in every province and receiving e-waste from e-waste suppliers (such as Singer and Abans). Yet, the major portion of the collected e-waste such as CRTs is not recycled within the country due to the limited technological expertise available. Instead, these e-waste components are exported through registered exporters in countries such as China, India and Pakistan, etc. CEA receives a certificate from these organizations stating the total amount of e-waste recycled. The next section of this chapter explains the e-waste recycling process in general.

The e-waste recycling chain/process can be divided into three major steps:

a. Collection,
b. Sorting/dismantling and pre-processing (including shredding, magnetic separation, etc.), and
c. End-processing.

Each step in this process is critical for the recovery of metals and moving towards a recycling economy. The following diagram shows the e-waste recycling process. It depicts how, after the end processing, recycled e-waste is consumed. After consumption they are again passed to the collection stage and the cycle goes on.

Steps in the e-waste recycling chain



Collection

The first step in e-waste recycling is collection. Without a successful collection system e-waste will continue to be stockpiled in homes, offices and warehouses. In countries like the US and Australia there are specific days for e-waste collection. Collection of e-waste could generally take place at regional or national level.

Various methods can be used to collect e-waste:

- Drop-off centers,
- Pick-up requests, and
- Take-back programs.

Drop-off centers

One effective method of e-waste collection is the use of drop-off centres where individuals and business organizations that produce e-waste are required to carry e-waste to a central location. The central location can be either an installed or mobile collection station or the reprocessing plant itself. People may be allowed to drop off some recyclables for free, at a fee or may even be paid for some metals such as copper or aluminum. Although this is the easiest method of collection its success is highly dependent on the participation of e-waste generators.

Pick-up request

Another method used to collect e-waste is pick-up requests. In this method purpose built vehicles can be used to pick up e-waste by visiting the sites of businesses and households at pre-specified time periods.

Take-back programs

There are also take-back programs where consumers can take back e-waste to retailers that distribute similar products. Take-back could be based on the purchase of a new product or replacement of old ones with new equipment. Further, there may be suppliers who collect e-waste from different households and deliver them to the recycling locations.

Sorting/dismantling and pre-processing

After the collection of e-waste, sorting, dismantling and pre-processing generally takes place at regional level or national level, and has the end goal of separating device streams into material streams, primarily, metals, glass and plastics for end-processing. At this stage, separating different elements in waste streams such as hazardous components and non-hazardous components takes place. Separating different elements is essential in the recovery of useful materials, in minimizing the amount of materials sent to landfill and in allowing recyclable materials to find a new incarnation.

Hazardous components like batteries, CRTs, and mercury bulbs are removed at designated sorting stations. There are three main methods used for the dismantling process:

- Manual dismantling,
- Semi-automated dismantling, and
- Automated dismantling.

Manual dismantling

Manual dismantling is the more traditional way to separate hazardous materials from recyclable materials, and to generate recyclable materials from e-waste. In a pre-sorting process, the incoming e-waste is first separated into different categories which are handled separately in the dismantling and sorting process that follows. The dismantling process itself is performed with simple tools such as screwdrivers, hammers and tongs. Manual dismantling results in high recycling efficiency and also supports local job creation.

Semi-automated and automated dismantling

Fully or semi-automated dismantling will gain importance in the near future in dismantling e-waste. Although dismantling is mainly done using manual systems, with the increasing amount of products to be recycled it is necessary to automate the process either partly or fully. In the semi-automated process both manual processes and machines are used. Automated dismantling takes place in the use of computers, robotics, intelligent systems and sophisticated machines.

Semi-automated dismantling systems considerably improve the working conditions of the employees involved in the process. In addition, it may enhance the quality of the whole recycling process while the skills of the workers can be used for more sophisticated jobs. On the other hand, semi or automated processing may reduce the job opportunities available for low or semi- skilled employees. It may also require advanced technology which can act as a constraint in developing countries.

In this dismantling stage, non-hazardous fractions such as iron, steel, copper, aluminum and plastics are separated from the hazardous components. Non-hazardous components can be resold or reintroduced into local production processes.

After the removal of the hazardous components, e-waste items are shredded into scrap metal and [fines?] using hammer mills. Metals and non-metals are separated during this stage using techniques similar to those used in mineral dressing[1] , e.g., screening, magnetic, eddy current and density separation techniques.

[1]*This is also known as mineral processing which is the process of separating commercially valuable minerals from their ores.*

Dusts which are generated as a result of pre-treatment processes can have a high precious metal content but also contain significant amounts of pollutants and high burn loss components like plastics. E-scrap should be sampled in order to assess the copper and precious metals content. Separated materials are then sent to the smelter [2].

It should be noted that the optimal level of pre-processing is dictated by the quality of feed requirements for end-processing. Excessive pre-processing not only increases costs but also leads to significant losses of precious metals. Therefore there is an optimal level of pre-processing that needs to be achieved.

End-processing

The final stage in the recycling chain of e-waste is the end processing, in which non-metal and metal fractions of e-waste are further processed. This process takes place at global level and the goal of this step is to recover valuable components (precious metals) and remove impurities.

The pyrometallurgical[3] method is the primary method used to recover precious metals. However, hydrometallurgical[4] and biometallurgical[5] methods have been gaining in popularity over the last two decades. End-processing of the more complex components of e-waste (e.g., circuit boards, batteries and cell phones) commonly occurs in smelters.

It is important to note that high grade e-waste can be sent directly to the convertor[6] and does not need to go through the smelting process. After smelting, the matte is then converted into impure copper called “liquid blister copper”, which is then refined in the anode furnaces[7]. The blister copper is cast into anodes that are then electro refined into pure copper.

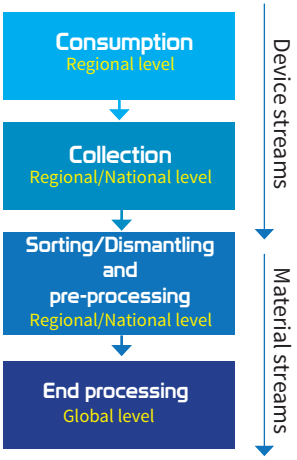
During the electro refining process, copper anodes are refined to produce pure copper cathodes and precious metals such as silver, gold, selenium and tellurium that settle as precipitates at the bottom of the electro refining cell. Finally, precious metal residues are melted, cast and refined to produce precious metal bullion.

Although plastic components cannot be easily recycled, smelting processes are able to use the energy content of the plastics.

The following diagram explains the e-waste recycling process/chain.

[2] *An equipment/process that is used to produce metal from ore.*
[3] *Pyrometallurgy involves high temperature processes in which chemical reactions take place among gases, solids, and molten materials. This is usually an older technology.*
[4] *Hydrometallurgy is a method for obtaining metals from their ores. It consists of leaching, solution concentration and purification and metal recovery.*
[5] *A bio-metallurgical process is a process in which mineral compounds contained in mineral ores or concentrates and constituting substrates for microorganisms are bio-oxidized to allow solubilization and separation thereof.*
[6] *Equipment used to convert the matte or e-waste into impure copper.*
[7] *A copper anode furnace includes a furnace drum which can be pivoted about a horizontal axis and in which copper melt is refined into anode copper by fire refining.*

E-waste recycling process/chain



5.4 Recycling of e-waste in Sri Lanka

The next table explains the specific recycling steps that take place depending on the nature of the item in the Sri Lankan context. As such the table itemizes e-waste categories, specific inputs that come under the category, the general process of recycling available in Sri Lanka and the output generated from the process.

E-waste treatment process in Sri Lanka

Waste category	Specific inputs	Recycling process	Output
IT and Tele communication equipments	Telephones, mobile phones, printers, motherboards, hard disks, RAM Cards, processors, circuit boards	Once these items arrived at factories, they are split into small parts using special machines which are run by air pressure. Then they are separated into several batches, based on the type of the item and packed into bags (e.g. motherboards are packed into one bag and then sealed). These bags are finally loaded to containers for exports.	Separated items are exported and some small parts and gadgets are set aside in order to sell in the local market (e.g. plastic items, wires, etc.).

Entertainment equipments	Televisions ,CD players	Televisions are recycled in the process same as above.	Same as above
Household appliances	Washing machines , air conditioners	There is no mechanism to recycle these appliances in Sri Lanka.	Not available
Lighting equipment	CFL Bulbs, fluorescent CFL Bulbs, fluorescent tube bulbs	The parts of the bulbs that contain mercury are separated manually by workers. Then, separated bulb parts are transferred to machines which generate glass fakers at the end. The aluminum caps and mercury dose is sent to specific containers. These containers are exported to countries such as Germany.	Mercury , aluminum caps , glass fakers and plastics
Electric and electric tools	Drills ,sewing machines	There is no mechanism to recycle these equipments in Sri Lanka.	Not available
Security and health care equipments	CCTV cameras, X-Ray machines	There is no mechanism to recycle this equipment in Sri Lanka.	Not available
Toys leisure and sport equipments	Exercise machines	There is no mechanism to recycle this equipment in Sri Lanka.	Not available

It is clear that Sri Lanka as a country only engages in collecting, sorting/dismantling and pre-processing of e-waste. Currently in Sri Lanka sorted or pre-processed items are shipped overseas for end processing due to lack of technological knowhow.

5.5 E-waste recyclers in Sri Lanka

In Sri Lanka, CEA plays a major role in promoting the proper disposal of e-waste and sometimes collecting e-waste. In addition, there are many other e-waste collectors and also recyclers in the private sector. Some of them are:

Collectors

- Metropolitan Office (Pvt) Ltd
- Singer Sri Lanka PLC
- Sri Lanka Telecom (SLT)
- Dialog Axiata

- Etisalat Pvt Ltd
- Mobitel Pvt Ltd

Recycling companies

- Asia Recycling (Pvt) Ltd
- Ceylon Waste Management (Pvt) Ltd
- Think Green (Pvt) Ltd
- Z-MAX Enterprises (Pvt) Ltd
- Green Link (Pvt) Ltd

The next section briefly explains the role of the above recycling companies.

Asia Recycling (Pvt) Ltd

Orange Electric, a leading CFL bulb manufacturing company, launched South Asia's first ever CFL and fluorescent bulb recycling plant operating under the name Asia Recycling (Pvt) Ltd. Asia Recycling is a joint venture between Nordic Recycling in Scandinavia and Orange Electric in Sri Lanka. This company is located in Pitipana, Homagama. The main objective of Asia Recycling is to provide a solution to environmental pollution in the country due to CFL and fluorescent bulbs.

The company has invested Rs. 600 mn in a recycling plant. This plant has the capacity to recycle up to 30 mn bulbs per annum. The company can undertake the recycling of any brand of CFL and fluorescent tube lights that are currently available in Sri Lanka.

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Asia Recycling is not profit-oriented and carries out the operations as a pure CSR project. Asia Recycling offers recycling services not only to the commercial sector but also to the domestic sector. The company offers Rs. 10 discount on new CFL bulbs when an old CFL bulb is handed over to an Orange Electric dealer. This is to encourage consumer involvement in its initiative to collect CFL bulbs without letting them go into dustbins/landfills.
(Refer http://www.orelcorparation.com for more details)

Ceylon Waste Management (Pvt) Ltd

Ceylon Waste Management is the only e- waste recycling factory approved by the Board of Investment (BOI) in Sri Lanka. It is considered the pioneer in the e-waste recycling industry in Sri Lanka. The company claims to be the market and the process leader in the industry. Ceylon Waste Management obtained an Environmental Protection Licence (EPL) for their factory. The company follows the guidelines of CEA for local operations and guidelines of UNEP for international operations.

Ceylon Waste Management provides customized e-waste disposal solutions for both corporations and individuals in the country. The company is currently refining twenty-one types of metals while conducting four process audits per year.
(Refer www.ewaste.lk for more details)

Think Green (Pvt) Ltd

Think Green is a recycling company specializing in providing eco-friendly solutions for disposed electronic equipment. Through the advances in recycling technology, Think Green uses several options to conserve as much resources as possible. Think Green is

authorized by CEA and mainly focuses on CSR projects to recycle e-waste.
(Refer www.thinkgreen.lk for more details)

Z-MAX Enterprises (Pvt) Ltd

Z-MAX Enterprises is a recycling company which is authorized by CEA to purchase used and disposed electronic items/gadgets from all government institutions by tender or on a contract basis. In addition, the company also receives e-waste from the general public. The company exports three containers per month on average.
(Refer www.mclloydbis.com for more details)

Green Link (Pvt) Ltd

Green Link is the first company to obtain local and international approval to export e-waste from Sri Lanka. Green Link, which targets to collect over 1,000 tons of e- waste per year, has shipped over 2,000 tons of e-waste to other countries for recycling in the past two to three years.

5.6 Various other e-waste management initiatives in Sri Lanka

In addition to these established recyclers, there are/have been many programs that aim to collect e-waste during a certain time period. These programs are described briefly below.

M-waste Initiative

As a CSR project Dialog Telekom voluntarily initiated a program to collect and store used mobile phones and accessories in 2008. Specially designed “drop off boxes” to collect used mobile phones and accessories were kept at Dialog Telekom’s collection points. The collected mobile phones were exported.

Corporate E-waste Management Program

CEA has launched a project along with 14 private sector partners to manage e-waste throughout their lifecycle. These partners include Sri Lanka Telecom, Mobitel, Dialog, Etisalat, Hutch and Lanka Bell from the telecommunications industry, Singer and Abans from the home appliances industry, Metropolitan, E-Wiz, Virtusa and ABC Trade and Investments from the office appliances industry as well as service providers Geo Cycle and Green Link. Through this program competitive companies joined together under a common theme.

These companies have entered into an MOU with CEA and implement their own corporate programs on e-waste management.

Under this program, Singer Sri Lanka and the Metropolitan Group of Companies have established collection points, island wide at their showrooms. Nearly 300 such collection points are currently in operation under the program. Within six months of this program 55 tonnes of e-waste had been collected (from January 2011to June 2011). All e-waste collected through partner companies are handed over to Green Link.

E waste drop-off events

The idea of holding e-waste drop off events is to take the e-waste gathered in households and private sector companies to a central location.

For the first time in Sri Lanka, an E-waste Collection Day was held on 7th April 2011 at Shalika Grounds, Narahenpita. The general public was made aware of it through newspaper advertisements and TV short messages. The Metropolitan Group and CEA jointly organized this event. A large quantity of e-waste items was collected during this day.

The second E-waste Day was held on 7 June, 2011 at Henry Pedris Grounds, Havelock Town, and nearly 4.2 tons of e-waste was collected within six hours. Event promotion campaigns were done through paper advertisements, radio campaigns and hand bills. According to the outcome of these two e-waste drop off events, it was noted that this is one of the most effective collection methods of e-waste in Sri Lanka.

Sri Lanka's National E-waste Management Week in 2014

As the regulatory arm for environmental management in the country, CEA declared a week from 27 May to 2 June, 2014 as the "National Waste Electrical and Electronic Equipment Management" week. It commenced under the theme of 'E-waste free Sri Lanka'.

The primary objective of the e-waste initiative was to minimize the adverse impact on the environment of the improper and harmful disposal of electronic items. Another objective of this e-waste week was to draw the attention of the people to the importance of safe disposal of e-waste and to facilitate their collection.

During this week, several institutions in the electronic equipment industry made arrangements to collect e-waste at district level, 24 hours a day. Provincial and district CEA offices, municipal councils, urban councils and provincial councils together collected e-waste accumulated in various locations and institutions.

The main event of this E-waste Management Week was the signing of an MOU between CEA and partner companies for the safe collection and disposal of e-waste. This e-waste week made it possible for the public to bring all their e-waste to the collecting centers. The collected e-waste was recycled locally and the rest was exported.

Chapter Six

Challenges and the Way Forward

Being a developed country, Sri Lanka faces numerous challenges in managing e-waste. The authors identified many such challenges in discussions with policy makers such as CEA, recyclers and the general public. Some of these macro level challenges were highlighted in Chapters 2 and 3. This chapter highlights the challenges in managing e-waste at a micro level, that is, from the recyclers' perspective. The chapter then suggests some solutions to these challenges and recommendations to uplift the current e-waste management practices in Sri Lanka. Finally, it highlights the role of the accountant in proper e-waste management in an organization, as the authors strongly believe that accountants can/ should play a very proactive role in managing e-waste.

6.1 Common challenges

Although there are many company-specific issues faced by e-waste recyclers, the following common challenges can be identified, which are mostly interlinked:

- **Lack of financial resources**

Since the recycling process of e-waste requires substantial capital and operational expenditure exceeding the income from the sale of the output, most recyclers are running their businesses amidst many financial constraints. This is a severe challenge which leads to many other challenges. Due to financial difficulties these companies face many problems such as inability to carry out research and development program, invest in the latest technology and provide adequate training to employees. Since they use out-dated technology in the recycling process efficiency is low when compared to global counterparts.

- **Lack of government support**

Due to the lack of government support, recycling companies face severe challenges. For example, there are no tax concessions granted by the government. They are subject to the normal business tax rate of 28%. The low return of the industry coupled with the absence of any special tax concessions discourages potential investors in the recycling industry.

- **Shortage of appropriate labour**

Recycling operations may affect human health adversely in the long run. Therefore employees engaged in these processes may encounter health issues in the long run. It is thus difficult to find employees who are willing to work in these companies. Even if employees could be found it is even more challenging to retain them. Complicated work involved in the recycling process and unattractive salaries in the recycling industry further worsens this situation. Most of the companies have to hire workers on a temporary basis which can lead to reduced levels of efficiency.

– **Inappropriate geographical location**

Currently most of the recycling companies are situated far away from the main cities. This is mainly due to environmental problems. However, significant transportation costs have to be borne by these companies when collecting materials, which adversely affect their bottom line. With the financial constraints they are already saddled with, it is almost difficult or impossible for them to find better business conducive locations which, in turn, makes it difficult to find suitable workers.

– **Inadequacy of materials**

Most of the recycling companies do not get a sufficient amount of e-waste to sustain their operations. The main reason is that the public is not aware of these companies or recycling options. As e-waste recycling is an emerging industry in Sri Lanka, lack of public or even corporate awareness on environmental, social and economic implications of e-waste is hindering the collection of materials.

– **Unfavourable public response to recycling operations**

Dismantling operations of recyclers often creates noise pollution. Also, improper disposal of recycled by-product items may cause communicable diseases like dengue. In some instances the public has taken legal action against these companies.

The next section of this chapter sheds some light on ways of overcoming these challenges.

6.2 Recommendation to improve e-waste management

In order to mitigate/overcome these challenges the following recommendations can be made. Some of them are relevant to policy makers such as the government or CEA and others to the recycling companies. The recommendations aimed at the recyclers can perhaps be viewed as general business recommendations.

Institutional/policy support

– **Greater support from the government and other relevant authorities/institutions**

Government should provide the necessary locations and infrastructure facilities for recyclers. In addition, a special concessionary tax system or tax incentives could be introduced to encourage existing and potential investors in this industry. Further, CEA can play an advisory role in helping recycling companies to successfully overcome the numerous obstacles they face.

In addition, concessionary loans and capacity building program (train and develop employees on e-waste management arenas) will be much valued by the industry.

– **Necessary action to raise public awareness of e-waste (recycling)**

CEA or other relevant authority with the help of the print and electronic media should launch a public awareness campaign on a regular basis. The general public and corporate

entities should be convinced of the social and environmental contribution that can be made by supporting proper e-waste management. More importantly, they should be informed of the financial benefits of proper e-waste. It should be emphasized that this would be a win-win situation.

– **Separate collection of e-waste**

The local authorities should promote the collection of e-waste items separately when they collect garbage. Currently these items are mixed with general waste and it makes recycling of these items difficult. The local authorities should therefore educate the general public on e-waste items and promote separate collection.

General business recommendations for recyclers

– **Enhanced employee training and development**

E-waste recyclers should have proper training program for their employees to develop and improve their knowledge, skills and attitudes. Since most of the employees lack knowledge about safety conditions, it is advisable to educate them on safety and health issues resulting from e-waste processing. Since most e-waste companies are labour-intensive, proper training would ensure the smooth flow of the functions while mitigating industrial accidents.

– **Embedded efficient business management practices and internal controls for routine processe**s

Recycling companies should implement proper internal controls that would lead to efficient performance of the process. Currently most e-waste recycling companies have manual operations plagued by many inefficiencies and wastages. Automation of the recycling process will aid recycling companies to be more efficient and productive in their operations. The general business practices and controls such as cash flow controls, budgeting and resource allocation, waste minimization, proper accounting systems, etc. would undoubtedly benefit the recyclers.

– **Greater allocation of funds for research and development**

Recyclers should provide a greater allocation for research and development activities. As e-waste recycling is a rapidly developing field, new technical knowhow should be acquired to understand recycling mechanisms/options for new e-waste items and also better e-waste sorting, dismantling and processing options.

6.3 The accountant`s role in e-waste management

Not only in managing e-waste but in implementing the sustainability agenda of organizations, accountants traditionally have not been playing an active role. With their wide knowledge and expertise in reporting and analysing financial as well as non-financial matters in a convincing and an effective manner, accountants can and should a play a pivotal role in waste management. Accountants themselves alone should not be blamed for this lack of involvement in sustainability (including waste) management. The traditional accounting education systems have not yet incorporated sustainability (accounting) education in required amounts. Further, little has been written to guide the

accountants on waste management. This is mainly attributable to the fact that waste or environmental management is still not considered a mainstream function of accounting. In an attempt to fill this lacuna of knowledge, the last section of this chapter provides some guidelines for accountants to manage e-waste in their respective organizations.

In managing waste that includes e-waste of an organization, accountants can get the support of traditional accounting tools. A waste audit is one such powerful tool, which can be used to manage e-waste also. An e-waste audit within an organization reveals how different e-waste types are generated, handled and treated at present. As an accountant, it is important to review these different types of treatment of e-waste to make them more effective in terms of economic, environment and social aspects. Hence, an e-waste audit can be regarded as the starting point of a sustainable e-waste management program of an organization.

When carrying out an e-waste audit, it is first necessary to identify and sort out different types of e-waste streams taking place within the organization. This would enable an accountant to have a better understanding of the different types of e-waste generated in an organization and also to identify their current treatment procedures. Depending on the information revealed from the e-waste audit appropriate action needs to be taken. The challenge is how to manage these different types of e-waste due to the lack of availability of standard and well established disposal procedures as outlined in the previous chapters of this book.

Being a developing country, Sri Lanka has less stringent regulations pertaining to e-waste. Lack of regulatory pressure has given the accountants more flexibility in financial reporting and internal management processes which could influence the internal management practices in a positive or negative manner. Companies can easily get rid of e-waste by simply handing it over to local authorities with other types of waste. These companies will hardly exert tangible efforts towards reducing the overall impact of e-waste on the environment and society. Yet, on the other hand, some companies can play a proactive role by separating e-waste from general waste streams and following a more structured approach in managing e- waste beyond simple regulatory requirements.

The lack of legal regulations and accounting standards in the area of waste management has also led accountants to make only a minimum contribution towards e-waste management in an organization. This necessitates either the introduction of regulatory requirements or accounting standards as a catalyst for, inviting greater involvement of accountants. Moreover, professional accounting bodies and universities have an important role to play in disseminating vital knowledge pertaining to e-waste.

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