Master's degree thesis

LOG950 Logistics

Title: Trends and Practices of E-waste Management through Reverse Logistics - A case study: Samsung Electronics Company

Author: Alaa Gaber Mahmoud, Abdelshafie

Number of pages including this page: 97

Molde, 27.05.2014

Molde University College

Mandatory statement

Each student is responsible for complying with rules and regulations that relate to examinations and to academic work in general. The purpose of the mandatory statement is to make students aware of their responsibility and the consequences of cheating. Failure to complete the statement does not excuse students from their responsibility.

*Please complete the mandatory statement by placing a mark **in each box** for statements 1-6 below.*		
1.	**I/we herby declare that my/our paper/assignment is my/our own work, and that I/we have not used other sources or received other help than is mentioned in the paper/assignment.**	☒
2.	**I/we herby declare that this paper** 1. Has not been used in any other exam at another department/university/university college 2. Is not referring to the work of others without acknowledgement 3. Is not referring to my/our previous work without acknowledgement 4. Has acknowledged all sources of literature in the text and in the list of references 5. Is not a copy, duplicate or transcript of other work	Mark each box: 1. ☒ 2. ☒ 3. ☒ 4. ☒ 5. ☒
3.	**I am/we are aware that any breach of the above will be considered as cheating, and may result in annulment of the examinaion and exclusion from all universities and university colleges in Norway for up to one year, according to the Act relating to Norwegian Universities and University Colleges, section 4-7 and 4-8 and Examination regulations** section 14 and 15.	☒
4.	**I am/we are aware that all papers/assignments may be checked for plagiarism by a software assisted plagiarism check**	☒
5.	**I am/we are aware that Molde University college will handle all cases of suspected cheating according to prevailing guidelines.**	☒
6.	**I/we are aware of the University College`s rules and regulation for using sources**	☒

Publication agreement

ECTS credits: 30

Supervisor: Halskau Øyvind

Agreement on electronic publication of master thesis

Author(s) have copyright to the thesis, including the exclusive right to publish the document (The Copyright Act §2).

All theses fulfilling the requirements will be registered and published in Brage HiM, with the approval of the author(s).

Theses with a confidentiality agreement will not be published.

I/we hereby give Molde University College the right to, free of charge, make the thesis available for electronic publication: ☒**yes** ☐**no**

Is there an agreement of confidentiality? ☐**yes** ☒**no**

(A supplementary confidentiality agreement must be filled in)

- If yes: **Can the thesis be online published when the period of confidentiality is expired?** ☐**yes** ☐**no**

Date: 27.05.2014

Preface

This master thesis is accomplished as the final part of the two years Master of Science in Logistics program at Molde University College in Norway. The thesis is written in the period from December 2014 to May 2014 under the supervision of professor Halskau Øyvind.

During my 2 years' study for my master's degree. A number of people made this journey meaningful to me. These include my classmates from my homeland Eman EL-akkad and Alaa Attia. Teachers in every course as well as the working staff in the Molde University College who gave me support on both life and study.

Acknowledgment

First of all, I want to thanks God who has always replied to my prayers and who gave me the chance to successfully carry out my studies at this advanced level. I extend my sincere gratitude to Molde University College who granted me a scholarship and helped me to realise my dream to study in a prestigious University, and to the Norwegian government for sponsoring my studies through State Education Loan Fund (Lånakassen).

I am highly indebted to Prof. Halskau Øyvind, my supervisor**,** for his support, guidance and advice, without which, I would not have been able to complete this thesis. He has always been a continuous source of inspiration for me.

I would like to thank my parents. You are the ones make me feel that even if no one thinks me to be good, I am the best in your eyes. You are the biggest insprition for me to do anything, thank you so much for your support. I am also very grateful to my sisters Randa and Shrouk.

This thesis is dedicated to my beloved husband Mohamed Rabia for his constant support and patience, for always being by my side and his sacrifice that made it possible for me to study. Without his believing in me I would not be where I am today.

I owe a depth of gratitude to Dr. Mostafa Rachid for his infinite support and valuable advice. I am very grateful to my best friend Omnia Abo Bakr for her friendship over 7 years. Thank you for sharing these years with me.

Abstract

Over the past decades, the reverse logistics field had been gaining more importance than ever before, which allowed companies to realize that profits and customer satisfaction are always derived from a good reverse logistics' strategy. There are several companies in all sectors interested in the reverse logistics' concept to achieve efficiency and sustainability. Certainly, one of these sectors is the electronics' sector where the customers need, every few years, to upgrade their technology and products that are transformed after a short period to waste. Accordingly, the urgent need for e-waste management was required, as the companies recognize that success depended not only on the strength in the market, but also on having an environmental system to recycle their wastes. As managing e-waste became a priority, developed countries are evolving systems for the collection and environmentally sound disposal of this waste. European Union is one of the very few region which have good experience in managing e-waste due to their strict regulations. The Arab Region, on the other hand, is now discussing the problems of e-waste. In this respect, the thesis tackles the management of electronic waste focusing on Samsung Electronics Company in Egypt and showing how the absence of regulation can influence on the company's behaviour.

***Keywords**: Reverse logistics, Consumer electronic market, E-waste management, EU legislation, Arab Region initiatives, Samsung, Egypt*

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ARF: Advanced Recycled Fee

B2B: Business to Business

BAN: Basel Action Network

BCRCs: Basel Convention Regional and Coordinating Centres

CE: Consumer Electronics

CEDARE: Centre for Environment and development for the Arab Region and Europe

CSR: Corporate Social Responsibility (CSR)

DARP: Devon Appliance Recycling Project

DP: Display Panels

DS: Device Solutions

DTIE: Division of Technology, Industry and Economics

EBITDA: Earning Before Interest, Taxes, Deprecation, and Amortization

EEB: European Environmental Bureau

EEE: Electrical and Electronic Equipment

EoL: End of Life

EPA: Environmental Protection Agency

EPI: Environmental Performance Index

EPR: Extended Producer Responsibility

ESCWA: Economic and Social Commission for Western Asia.

EU: European Union

GCC: Golf Cooperation Council

GDP: Gross Domestic Product

GEEP: Global Electric Electronic Processing

G-ERP: Global Enterprise Resource Planning

GeSI: Global e-Sustainability Initiative

ICT: Information and Communication Technology

ICTD: Information and Communication Technologies for Development

IM: IT & Mobile Communications

IPR: Individual Producer Responsibility

ITU: International Telecommunication Union

LSI: Large Scale Integration

MCIT: Ministry of Communications and Information Technology

Mobile Phones Partnership Initiative (MPPI).

NGO: Non-Governmental Organization

NRC: National Recycling Collation

OECD: Organisation for Economic Cooperation and Development

OEM: Original Equipment Manufacturer

R&D: Research and development

RAC/CP: Regional Activity Centre for sustanabile Consumption and Production

ROHS: Restriction of Hazardous Substances Directive

S.T.A.R: Samsung Take-back and Recycle program

SAICM: Strategic Approach to International Chemicals Management

SRD: Samsung Recycling Direct

StEP: Solving the E-waste Problem

SWM: Solid Waste Management

TSDF: Treatment, Storage and Disposal Facilities

UAE: United Arab Emirates

UN bodies: United Nation bodies

UNDP: United Nations Development Programme

UNEP/MAP: United Nations Environment Programme/ Meditranian Action Plan

UNEP/ROWA: United Nations Environment Programme/ Regional Office for West Asia

UNEP: United Nations Environment Programme

VOC: Voice Of Customer

WEEE: Waste Electronic and Electrical Equipment

XRF: X-ray Fluorescence spectrometer

Chapter 1: Introduction

1.1. Background

Consumer electronics have been considered an important part of daily life. It revolutionized the way people communicate, entertain ourselves, and retrieve information. The rapid developments in the electronics sector over the past few decades achieved an unprecedented growth record in terms of sales, exports, innovative capacity, and spin-off potential for related activities. Accordingly, this development causes a constant stream of new products with decreasing short life span. Hence, the rate of disposal has been on the rise, more and more discarded devices are thrown away, and the volume of e-waste has significantly increased causing different dangerous problems. As technology grows quickly and electronics reach to the end of their life span faster, there is an urgent need for end-of-life management options (also known as e-waste management).

Electronic wastes contain several metals, many of which are valuable, and some of which are hazardous. Thus, managing e-waste is imperative to recover the precious components and to reduce the environmental impact by handling the hazardous substance properly. Recovering processes include reusing, refurbishment, repairing, recycling, or disposal. Reuse, refurbishment, and repair are considered the most desirable methods for recovering as they help in extending the life span of the product.

Dealing with e-waste management is a long term activity that requires cooperation between all stakeholders and technological advancements. In most developed counties, the integrated electronic waste management has been well developed and adopted. For instance, e-waste management in Europe provides a good example for dealing with the growing e-waste issues through serious laws and regulation and besides the high customer awareness. Consequently the electronics manufacturers are committed to be in line with the current regulations and customers' culture. They have to manage their discarded product in a friendly manner. On the contrary, most developing countries have not adapted themselves to the concept of e-waste management where the recycling rate of e-waste is still relatively low. There are many obstacles to recycling e-waste in the developing countries, including the lack of recycling infrastructure and lack of national regulations beside the breach of the laws by some developed countries which export their wastes to developing countries such as Nigeria, Ghana, and other parts of Africa and Asia.

According to the difference in regulations of each country, it is normal that the trend of electronic manufacturers differs from one country to another. There are some electronics companies who do not stick to their responsibilities in the developing countries as they know that there are no penalties or extra taxes. On the other hand, they are committed to apply a strict e-waste process in developed countries by design electronics which have longer lifespans, use fewer and less-hazardous materials, and recycling the end of life products in a way which protects both the human health and the environment.

In Egypt, the growing population and the increasing number of people who use electronic products led to a strong movement in the electronics sector causing inflation of the e-waste problem as Egypt does not have a good e-waste recycling network. The Egyptian government have legislations related to the waste issues, but implementation of these regulations does not take place, and accordingly most of the electronic manufacturers does not follow any guidelines to manage their wastes there.

The electronic waste management principle has been implemented by many countries as the most suitable approach to handle the e-waste problem. However, the Egyptian government and private sector can formulate a sustainable e-waste system based on the experience gained from the developed countries.

1.2. Problem Statement

Most of international electronic companies have a tendency to see the end-of-life products in a developing countries as a waste stream not required to be managed. Further, they do not devote any time or effort to treat their waste in these countries. They think that selling new products is more effective than spending money and resources on treating discarded equipment, especially if those countries do not have a legal framework for e-waste management. Another issue that needs to be discussed is the compliancy of developing countries' governments with enhancing the law of e-waste recycling. Therefore, the author is interested to investigate this issue in Egypt as a developing country with fast growing quantities of electronic waste, and Samsung as a leading company has several programmes related to handling and recycling e-waste around the world.

1.3. Purpose

The purpose of the research is to gain a deeper understanding of the importance of reverse logistics for the electronic industry showing the best practices for handling the e-waste. It seeks to investigate the different trends of national companies when they deal with countries according to their legislations. Further, the research will describe the main rules and regulations for e-waste management in European Union as representing developed region and the Arab area as a developing region. The thesis will mainly focus on Samsung's practices for e-waste management in Egypt to explore how they can contribute to solving this issue.

1.4. Scope and Limitation

The study focuses mainly on hazardous waste management which comes from the end of electronics products' life. The study is limited to the Egyptian situation and focuses on Samsung Electronics Company as a case study. However, the study describes the environmental knowledge and information, as well as the appropriate e-waste treatment processes, which may be useful in addressing the problem in Egypt. Further, this research looks for some initial steps which could help in overcoming the challenges of applying true e-waste management in Egypt.

1.5. Research Question(s)

To achieve the goal, the following research question will be addressed:

How Samsung Electronics Company deals with its waste globally and in Egypt? What are the differences-if any? What can be learned to apply true e-waste management in Egypt?

In order to answer the research question, it is expected that the following sub-questions need to be addresses in a more specific way:

- What is the main process of reverse logistics to manage the e-waste?
- What are the barriers and obstacles for e-waste management implementation?
- Are there any strict regulation for e-waste management in the Arab region such as the EU directives?
- What is the fate of Samsung electronic devices in Egypt?
- What are the legal framework for e-waste management in Egypt?
- What are the procedures that Samsung and Egyptian government have to implemet to achieve a significant e-waste management?

1.6. Thesis Outline

This thesis has been divided into seven chapters as follows:

Chapter 1: Introduction

In the first chapter, the introduction, an attempt has been made to present an overview of the thesis framework and the motivations behind the choice of this particular topic. In addition, it provides an idea of the development of the research and the problem statement which is used to address the purpose showing the research methodology of the research.

Chapter 2: Reverse logistics Theoretical Framework

This chapter presents a broad review of literature, addressing the concept of reverse logistics as an appropriate approach to manage the problem of waste management without reference to the electronics industry.

Chapter 3: Research Methodology

This chapter elaborates how the data will be gathered and how this research will be written and conducted introducing the research strategy and the empirical techniques applied.

Chapter 4: The Consumer Electronic Market and E-Waste Management

This chapter give an overview of the consumer electronics sector and its characteristics and trends. Then, it deals with the electric and electronic waste management and the best practical stages for treatment the End-of-Life (EoL) devices. This chapter also explains the scale and international flow of e-waste proving that some developed countries transfer its responsibility to the developing countries.

Chapter 5: Regulations of e-waste management (EU directive and Arab area regulation)

This chapter looks at the European Union directive as a good example for handling e-waste, achieving the highest recycling rates yearly. It illustrates the current stance of the Arab region towards the e-waste legal framework and the role of international institutes in addressing this global problem.

Chapter 6: Samsung Electronics Company

This chapter is divided into two sub-chapters, the first one focuses on Samsung as an electronic company, investigating some information about the company and its value chain and exploring

how they deal with their waste globally. It also discusses whether Samsung treats its e-waste in Egypt just like what it does globally, showing Samsung's contribution to solving this problem. The second part describes the fate of Samsung devices in the Egyptian e-waste approach. Further, it give a detailed description of recycling network in Egypt to manage the EoL electronic, followed by, the challenges which face the Egyptian society to implement true e-waste management in an acceptable level.

Chapter 7: Discussion and Analysis

This chapter summarizes the requirements to implement true e-waste management in Egypt, discussing some recommendations for the Egyptian government, the private sector, the leading company, the civil society and the consumer to overcome the challenges. This chapter also highlights the main points discussed in this thesis and concludes this descriptive research and in the end, it proposes some issues for further research.

Chapter 2: Theoretical Framework of Reverse logistics

This part of the literature review presents and explains the definition and significance of the reverse logistics, it also focuses on the reverse logistics types and activities, and other closely related theories which are of main focus of the study.

2.1. Defining Reverse logistics

There are great variety of definitions of reverse logistics which changes in scope and significance. Reverse logistics is usually regarded as a relatively new field of research which have received much attention due to its direct impact on profit margins mainly during the last two decades. However, some reverse logistics practices (recycling and solid waste management) were well known long before this period of time and as such they have been a topic of interest for various researchers.

Beckley and Logan (1948) refer to the idea of returning products, without explicitly attributing the name of reverse logistics to it. Similarly, Terry (1869), Giultinian and Nwokoye (1975) refer to the same idea, without any reference to reverse logistics. In defining Reverse Logistics as the direction of product from the end customer to producer in a distribution channel, Murphy and Poist (1989, p.12), were the first authors to use the term of Reverse logistics.

In the early 90s, the Council of Logistics Management published the first definition of Reverse Logistics mentioned by Stock as *"The term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal"* (1992). This definition includes all related logistics activities and also the standpoint of waste management

Pohlen and Farris II, (1992) recognize that there are three problems regarding reverse products flowing. The first one is that most of the logistics systems are not equipped properly to handle the movement of products going backwards. The second one is about the costs of reverse distribution that can be as much as nine times more than the normal forward flow. The last reason is that returned goods cannot be transported and/or handled in the same way as in the forward flow. This is due to the lack of sufficient data and technological system which can be very helpful in expecting and tracing the returned products.

On a larger scale, Krupp (1993) focuses on reverse logistics by suggesting that the forecasting of manufacturing sales must be accurate and optimal, as it reflects on the uncertainty and the variety of main returns for the new parts. Krupp concentrates on the manufacturing sector, since manufacturers free themselves from the responsibility of the returned products after they had been sold to the end customer.

While White (1994) discusses the importance of reverse logistics for product handling, material handling, distribution, transportation, moving, storing, protecting and controlling materials. In the same year, Webb (1994) studies the green movement as an important environmental concern which influences reverse logistics activities. Dawe (1995) investigates how the company that has the ability to manage its returns has a good opportunity to achieve a competitive advantage and gain customer loyalty.

Fuller & Allen (1996) show that the companies can manage their product waste economically through the conversion processes, which support the sustainable development. Certainly, they point out how using the feedback information effectively helps reverse logistics' networks with recyclable materials and support the passage of recycling bill.

Many researchers use quantitative models to measure the reverse logistics practice performance's efficiency. Clegg, Williams, and Uzsoy (1995) use a linear programming model to know the influence of recycling and remanufacturing on the companies' operations, and to analyse the recovered items' viability in remanufacturing operations. Other models used to develop the dimensions of reverse logistics practices (why, how, what and who), which help in deep understanding of reverse logistics chain by researchers such as Fleischmann et al. (1997), Guide Jr, Srivastava, & Spencer (1996), and Kroon & Vrijens (1995).

Giuntini and Andel (1995, p. 73) clarifies that the reverse logistics is "*an organization's management of material resources obtained from customers*". They discuss various reason that lead to the high level of returns such as; *increased use of direct sales channels, tightening environmental legislation, heightened environmental awareness, shorter product life-cycles, and selling utilities instead of products*. Despite the fact that they discuss many different principles and forms of reverse logistics and explain its significance, they do not focus on the direction of flow. Thierry et al. (1995) explain the revers logistics from another point of view; through the product recovery management which is identified as: "… *the management of all*

used and discarded products, components, and materials that fall under the responsibility of a manufacturing company."

More details are suggested by the Council of Logistics Management. They published two studies related to reverse logistics. In the first, Stock (1998, p. 20) point out that the term of Reverse Logistics was used to refer to "*the role of logistics in product returns, source reduction, recycling, material substitution, reuse of materials, waste disposal, and refurbishing, repair and remanufacturing*". In his argument of how the reverse logistics programme can be operated, Stock tries to explore the potential importance of reverse logistics. The second study was written by Rogers & Tibben-Lembke (1999), in which they conclude that the extensive collection of industry statistics data related to reverse logistics business include identification for an optimal recovery and disposal options for returns. In this sense, they describe Reverse Logistics as:

The process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or for proper disposal.

Here it is important to know that De Brito and Dekker (2002) criticize the existing definition of reverse logistics which was provided by Rogers and Tibben-Lembke (1999). They add: "*We do not refer to 'point of consumption' (…) nor do the products need to be returned to their origin (…)*" and give example from real-life economy, proving that reverse logistics could exist even if material resources are sent backwards, not from the point of consumption and to the point of origin, but from any stage of the supply chain to any other stage in the same chain. Thus the definition is changed to:

The process of planning, implementing and controlling flows of raw materials, in process inventory, and finished goods, from a manufacturing, distribution or use point to a point of recovery or point of proper disposal. (De Brito and Dekker, 2002)

Dowlatshahi (2000, p. 143) defines the Reverse logistics as "*a process in which a manufacturer systematically accepts previously chipped products or parts from the point for consumption for possible recycling, remanufacturing or disposal*." He describes the reverse logistics by 11 internal and external factors. However, he divide these factors into two categories: internal strategic factors and operational factors. The strategic factors include overall quality, customer

service, cost, strategies, legislative, and environmental concern, whereas the operational factors consist of cost benefit analysis, supply chain management, packaging, remanufacturing and recycling.

According to EL Saadany and Jaber (2011), the concept of reverse logistics has gained more attention in the last decades, due to the increasing awareness of environmental protection. They refer that reverse logistics focuses on issues such as reuse, refurbish, reclaiming, recycling, remanufacturing, take back, and disposal.

2.2. Importance of reverse logistics

Over the past decades, the significance of reverse logistics had been growing more than ever before. Furthermore, the researchers are realizing their responsibility to increase theoretical knowledge in this field due to the fact that reverse logistics operations in a supply chain management could be considered as a first step to innovative services of a company's targets. The efficient reverse logistics' strategies have a direct impact on a firm's performance, internal cost, expand revenue, improved inventory management, and customer service. Individual companies can achieve these goals when they can maximize their efficiency and effectiveness simultaneously, bringing the trade-offs between cost and quality, and between price and customer service on stage (Ballou, 2004). There are many companies still do not have the ability to implement an efficient reverse logistics system (Govindan et al., 2012), because it could be risky for the top management as it involves financial and operational aspects, and as a consequence good opportunities are often missed (Elmas & Erdoğmuş, 2011).

Additionally, the environmental concern around the world forces companies to be responsible for their returns such as; marketing returns, damage or quality problems, overstocks, refurbishing or remanufacturing. Handling all these types of returns is a considerable challenge for companies, and in many cases it becomes a necessity for customers' satisfaction. A good reverse logistics strategy not only includes the recovery of returned products, but it also helps companies to meet their corporate sustainability goals, such as lowering carbon footprint. However, the process of closing the supply chain loop proves to be beneficial through its economic contribution for the firm, its environmental attitude, and the increased customer's satisfaction (Bernon and Cullen, 2007). Hence, implementing good reverse logistics system is becoming an area of competitive advantage.

Kokkinaki (2001) outlines the benefits of implementing reverse logistics strategy in the following points:

Positive environmental impact: producer responsibility laws acts force the manufacturers to improve the collection policy to benefit from the products till the end of their life cycle without any pollution.

Competitiveness advancement: good handling of used products leads to decreasing costs, satisfying customers, and increasing profits. As a sub sequence, the company can achieve a competitive advantage in the market.

Regaining value: successful reverse logistics can achieve values through recovering discarded products or parts. Moreover, the companies which, previously, did not dedicate time or energy to manage their reverse logistics system, have begun to pay attention.

2.3. Types of reverse logistics

Rogers and Tibben-Lembke (1999) differentiate the return items between products and packaging which are summarized in table 1, but this classification is too general. So, after two years De Brito and Dekker (2002) classify the categories of returned items in much more detailed way. They differentiate the products into *foods, civil objects, consumer goods, industrial, transport and military equipment, oils, chemicals and pharmaceuticals.* This classification is more detailed and exhaustive, it shows that implementing the recovery options for each products is different as each type of product has its own unique characteristics which need a unique way for reusability.

Table 1: Types and activities of reverse logistics

Material	Reverse logistics activities
Product	Return to supplier Resell Sell via outlet Salvage Recondition Refurbish Remanufacture Reclaim materials Recycle Landfill
Packing	Reuse Refurbish Reclaim materials Recycle Salvage

Source: Rogers and Tibben-Lembke, 1999, p.10

2.4. Barrier of Reverse logistics activities

Rogers and Tibben-Lembke (1999) examine 300 companies in different sectors which have faced many barriers during implementing good reverse logistics operation. When they ask about the obstacles with reverse logistics implementation, the answers indicate different internal and external barriers as grouped in the following table:

Table 2: Barriers of reverse logistics

Barrier	Percentage
Importance of reverse logistics relative to other issues	39.2%
Company policies	35.0%
Lack of systems	34.3%
Competitive issues	33.7%
Management inattention	26.8%
Financial resources	19.0%
Personnel resources	19.0%
Legal issues	14.1%

Source: Rogers and Tibben-Lembke, 1999, p.33

According to the respondents, the largest barrier to implement successful reverse logistics strategy is the unimportance of reverse logistics management compared to the other company's specialization. Most importantly, the lack of awareness of the reverse logistics benefits and the slow change in the management's attitude could be a main factor for resistance to change, whereas, reverse logistics operations require a radical change in the mindset and practice to achieve efficient reverse logistics processes. (Ravi and Shankar 2004)

The second largest number of respondents pointed out the restrictive company policies and the aggressive company behaviours which may be related to the unimportance of reverse logistics. As a results, the recovering processes for returns are inefficient and out of practice.

Lack of systems is a very serious problem regarding reverse logistics implementation. A good information and technological system is necessary for supporting the reverse logistics operations as it needed for tracing the product and forecasting the returns.

Competitive issues constitute a serious problem that hampers the implementing of good reverse logistics. The reverse logistics can give the company a competitive advantage represented in economic benefit, by recovering the commercial returns for reuse, remanufacturing, recycling, or a combination to add value to the product.

Management inattention is a major barrier for successful reverse logistics. Efficient leadership who realizes the importance of reverse logistics should provide clear vision for reverse logistics programs. They should integrate the activities of reverse logistics with all the supply chain members, and provide continues support for reverse logistics in the company's strategic plans.

Financial constrains were cited as barriers by 19 percent of those surveyed. However, finance support is one of the main factors which lead to good reverse logistics operation. In this sense, implementing true reverse logistics needs allocation of funds and other resources. Having an efficient information systems, which makes the reverse logistics more profitable, is necessary, but it needs financial support (Ravi and Shankar 2004).

The lack of training and education are significant barriers for commercial recovery implementation. In this sense, awareness of personnel issues is a prime requirement for achieving success in any company. The personnel training should be provided in critical business functions to increase their qualifications. Finally, the problem which has the smallest influence on reverse logistics operation is legal issues. These issues do not appear to be a major problem because many government's regulations encourage companies and organizations to be responsible for their waste and returns.

2.5. Drivers of reverse logistics

The drivers of reverse logistics policies and practices differ from one company to another, in large part depending on the perceived importance of this activity to the business. De Brito and Dekker (2002) as well as Bernon and Cullen (2007) explain the driving forces behind the reverse logistics implementation in details. The framework of De Brito and Dekker differentiates between the internal and external drivers, while Bernon and Cullen specify the reasons for the existence the reverse logistics operations by emphasizing the activity of the company which causes return flows. The following points illustrate the drivers of reverse logistics according to De Brito & Dekker (2002);

2.5.1. External drivers of reverse logistics

The external drivers of reverse logistics are forces outside the scope of companies and customers (economic and extended responsibility), which impact the decision making related to implement reverse logistics operations.

- **Economic drivers (Direct and Indirect)**

Within the framework of reverse logistics, economic drivers are the possibility to recover economic value from products that are being taken back. Recovery may be cheaper than manufacturing or buying new products or raw material.

The direct economic drivers for companies which recover their returns is increasing their revenues and profits through decreasing the operation cost. For example, getting used or damaged products from the end customers as returns, give the company the opportunity to achieve advantage through obtaining the valuable and expensive materials which may be needed in the other operations.

On the other hand, companies get different indirect benefits related to reverse logistics processes. For example, the company can achieve competitive advantage and beat its competitors through improving their image in the market by declaring their environmental awareness or by promoting green products (Rogers and Tibben-Lembke, 1999). The indirect drivers can be from the governments which encourage companies to be more environmentally-friendly as companies can get governmental support by, for example, lowering taxes, grants for green practices, or providing particular market through state contracts. Getting the end-life products from customers could lead to increasing their satisfaction, as well as giving feedback to the company about their sold products to improve the production technologies.

- **Extended manufacturers' responsibility**

The extended manufacturers' responsibility is one of the external reverse logistics drivers, according to De Brito and Dekker (2002). It is an idea mention at the protection environmental strategies. The extended manufacturers' responsibility *includes various preventative measures represented in the disposition of end-of-life products, stimulates the implementation of cradle to cradle philosophy, suggests incentive mechanisms for companies to work upon closing the supply chain loop and to constantly improve their production processes and products* (Rossem et al., 2006).

2.5.2. Internal drivers of reverse logistics

The internal drivers are represented in reusing, remanufacturing and recycling which happen inside the companies. These processes influence the relationship between companies and their customer satisfaction. Hence, the internal drivers of reverse logistics occur during the manufacturing level, the distribution level or after-sales level (De Brito and Dekker, 2002).

- **Drivers of reverse logistics on manufacturing level**

This type of driver aims to recover the products during the production stage. De Brito and Dekker (2002) state that the return drivers in the manufacturing level are emitted from the production that fails quality testing, which means that some items need to be recovered during the production stage through sending back to the manufacturing operation for rework.

- **Drivers of reverse logistics on distribution level**

The reverse logistics operations could occur after the manufacture stage and before selling to the end user. Mostly, these situations happen because faulty or dangerous products are caught up in their supply chain. In this situation, the manufacturer recalls all the defective products to perform actions on them such as; disposal, repairing or remanufacturing. After finishing the required safety conditions, the producer sends them back to the market (Stoyanov 2012). According to De Brito and Dekker (2002), this process is called product recalls[1]. De Brito and Dekker (2002) state that the commercial returns also need reverse logistics processes on their distribution channel by sending the unsold or outdated products from retailer to the manufacturer because of contractual arrangements. They add two concepts of distribution returns: the first one is stock adjustment, for example, redistribution products between different shops or warehouses, and the other is functional returns such as; packaging and pallets which are designed to move through supply chain processes.

- **Drivers of reverse logistics on after-sale level**

The importance of reverse logistics operations could appear after selling the product to the final customer (De Brito and Dekker, 2002). The customers can return the product after thier purchase shortly (reimbursement guarantees). Customers can also return their products if these products do not function correctly (warranty returns), or need service maintenance (service returns). Similarly, many products which are not required by the customer are returned back to the supplier (end-of-use returns) or products which have reached to their useful life (end-of-life returns). In these situations, the company had to accept the returned products and try to choose the proper solution by implementing the reverse logistics policy.

[1] The famous example for product recalls on distribution level is Toyota vehicle recall crisis from 2009, when Toyota automobiles found that there were dangerous vehicles on the market because of unintended acceleration. To solve this crisis, Toyota implemented multiple recalls of more than 10 million vehicles worldwide due to accelerator pedal and floor mats flaws that were responsible for the unintended acceleration problem (Tsikoudakis, 2011).

While the drivers responsible for the occurrence of reverse logistics processes according to Bernon and Cullen (2007) are: *(1) forecast accuracy and demand variability; (2) purchasing policies; (3) high on-shelf availability; (4) liberal return policies; (5) legislative factors; (6) new product introductions; (7) logistics trade-offs; (8) customer no-faults; (9) cash flow management practices; (10) promotions; (11) product ranges and safety stocks; and (12) product life- cycles.*

2.5.3. Reverse logistics main processes

Rogers and Tibben-Lembke (1999), Fleischmann et al. (2000) as well as De Brito and Dekker (2002) identify the following key processes of reverse logistics: *(0) Gate-keeping; (1) Collection; (2) Inspection / Selection / Sorting; (3) Disposition; and (4) Redistribution*

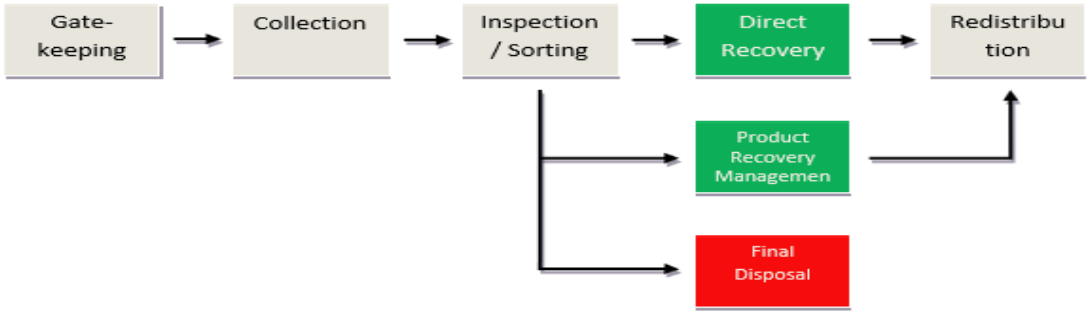


Figure1: Main reverse logistics processes (*Source*: Stoyanov 2012, Adapted from Thierry et al, 1995)

2.5.3.1. Gate-keeping

Gatekeeping represents the main entrance of reverse logistics flows. It is a set of screening procedures employed by retailers to determine how, and which products are allowed to enter the return stream for recovery or proper disposal, and which are not. Successful gatekeeping knows that not all products should enter the reverse logistics flow, because the cost of transporting and processing for some return products is higher than the product value itself and it could be more costly. Subsequently, this process needs a good understanding of the cost of returns, relative to each product value (Mollenkopf, 2010).

2.5.3.2. Collection

The product collection process aims at gathering discarded products from customers to the recovery point (De Brito and Dekker, 2002). In this process, the transportation and inventory costs of returned products, differs from product to another according to the type of reverse logistics system which could be implemented. There are two approach for collecting the

discarded products; the **centralization system** which contributes to integrating discarded materials and products from various retailer's locations through bringing them to a central facility for testing. This system is implemented through take-back programs sponsored by retails and manufacturers. This type of return system is designed to minimize both transportation and processing cost through economic of scale.

Another structure being discussed by many authors is the **decentralized return system**. This approach helps in reducing time delays in return flow system because it could be inspected in retailers' location, then sends products directly for recovering. The transportation and operation costs in this system increased compared to the centralization system as products are shipped in smaller sizes (Rogers and Tibben-Lembke, 1999). Besides, the labor cost in the retailers' location could be increased due to the fact that the product evaluation needs extra skilled workers who can evaluate the returned products accurately. The activities of reverse system during collecting process consist of transportation, warehousing, distribution and inventory management, and these activities have to be at the minimal cost and maximum value.

2.5.3.3. Inspection / selection/ sorting

After the collecting process, the condition of discarded products must be evaluated and the suitable form of treatment has to be determined. According to Rogers and Tibben-Lembke, (1999), "*It is normal that customer return used or non-used products for a million of different reason*" and all these reasons could not be evaluated by distributors or manufactures. Hence, it is important for the company to implement the inspection process when the returns arrive to the recovery location. This process starts with disassembly, testing, sorting and rating the returned product which helps to determine the characteristics and quality level of products to be easy for the company to identify the most profitable and appropriate strategy for each one (Guide & Van Wassenhove, 2002).

2.5.3.4. Disposition

According to Prahinski and Kocabasoglu (2006), it is necessary for the company to ensure that the total cost of recovery product does not exceed the cost of new one. As shown in figure 1, the disposition options for the returned products are divided into three groups; direct recovery, product recovery management and final disposal. These subgroups are suggested by (Thierry et al, 1995), and they arrange these group according to the product disassembly degree.

Direct recovery

According to De Brito and Dekker (2003) direct recovery is usually implemented when the state of the returns is evaluated to be "*as-good-as-new*" or when their condition is satisfactory enough. In this case, the returns are sent back to the reverse flow system to recover. After that the company can resell them as new brand if their condition is still good and if they will not affect the company's reputation. The product may requires to be repackaged so that customer does not know that it is being resold. However, in some industries, it is not allowed for the companies to re-sell the returns as new product. For example, it is illegal in some countries to sell a circuit breaker which has previously been installed (Rogers and Tibben-Lembke, 1999). On the other hand, if the product has visible signs of wear, there is a good chance to re-sell it via the secondary market at low prices in order not to harm the image of the company.

Product recovery management

The majority of return product, which cannot perform their function or which have reached to the end of their useful lives, are moving toward the reconditioning process to be useable and profitable again. However, the valuable components and used items need a degree of intervention which occurs through recovery management (Thierry et al., 1995). This intervention depends on the condition of returns products which is represented in many activities as shown in figure 2; *(1) repair; (2) refurbishment; (3) remanufacturing; (4) cannibalization / retrieval of parts; and (5) recycling.*

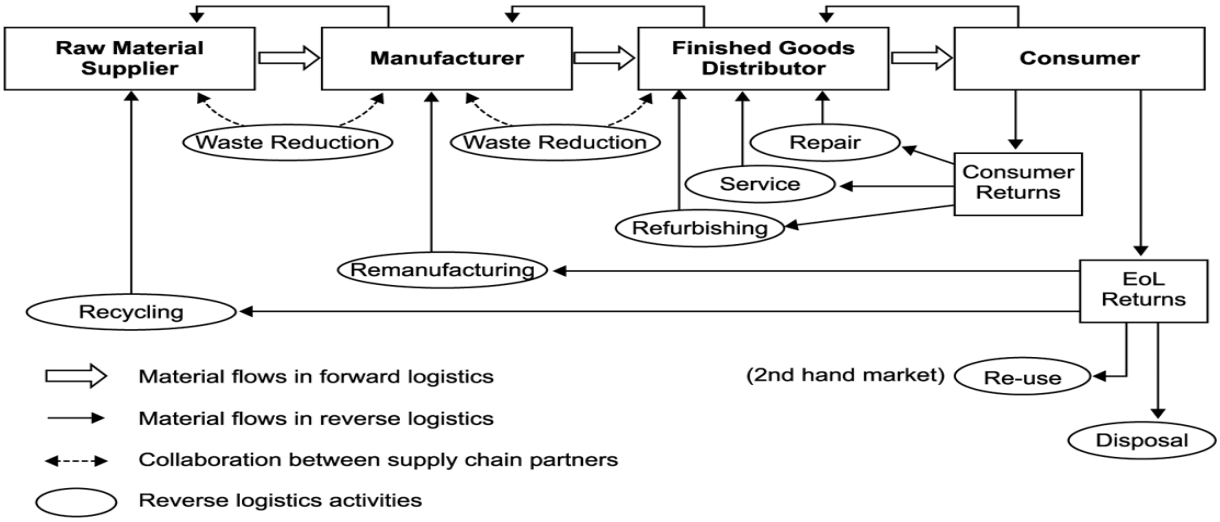


Figure 2: Basic flow diagram of reverse logistics activities (*Source*: Lau, K. and Wang, Y. 2009, Adapted from Srivastava 2008)

- **Repairing**

The repairing process is implemented to return the products into the working condition again. Typically, the quality of repaired products is less than the quality of new ones, but some product's evaluation can identify that fixing or replacing some broken/invalid parts is sufficient to restore the product as a new one without affecting its main function. This process usually does not require a lot of disassembly, because it can either be performed fast and directly at customer's location or special manufacturer's centres (Thierry et al., 1995).

- **Refurbishing**

The company resorts to the refurbishment process when the simple repair of defective parts is not efficient enough. The successful refurbishing aims at improving the product's performance, extending their service life and bringing them up to an acceptable quality level. Very often, it is cheaper for expensive products to be refurbished instead of replacing the whole product by new one. Moreover, the returns are disassembled to separate items and modules which are subject to an accurate screening, inspection and testing process to replace or fix the outdated or damaged parts (Thierry et al., 1995). Military and commercial aircraft are examples of expensive products which are refurbished, but surely the average of their remaining service life is shorter than the service life of new ones (Stoyanov 2012). Likewise, the automobile sector is one of the common sectors which implements the refurbishing process, especially for the expensive car's mechanism, such as gear boxes, clutch mechanisms etc.

- **Remanufacturing**

A remanufactured product possesses aim to make the product's quality standard, life expectancy and performance like that of a new products. In order to do that, the company has to take deeper interventions. All components of returned products are fully disassembled and inspected. The outdated, worn-out or damaged materials are changed with new parts, and the exchanged parts are fixed and evaluated. In this scene, the company should identify which remanufactured items meet the quality standard. Further, the customer can purchase high quality product with low price and full warranty (Thierry et al., 1995).

- **Cannibalization/ Retrieval of parts**

In the previous product recovery options, the condition of the returned product that is either out-dated, defective or damaged is scalable for recovering. In cannibalization, there are a few applicable parts from used components which could be recovered, these parts are considered potentially valuable. While the remaining parts of the product would not be value enough for

recovering, they could be recycled or disposed. The cannibalized parts are evaluated and collected to be reused in the process of repair, refurbishing, and manufacturing of other products. The performance level of cannibalized parts depends on the process in which they will be reused. According to Thierry et al. (1995), this process is called cannibalization, while De Brito and Dekker (2002) refer to this process as retrieval of parts.

- **Recycling**

On the contrary, the function of recycling process does not contain the recovering of product or components as the last product recovery options, recycling, aims to retain the functionality of composing materials as much as possible. For this reason, the return products are disassembled into parts and grouped in different categories of materials. Subsequently, if these materials have high performance level, they are usually reused in new production process (Thierry et al., 1995).

Final disposal

When the returned products and materials could not be recovered any more, they should be disposed. The disposal process is implemented either when the physical value of recovery could not be achieved or when the economic and technological cost would be too high (Fleischmann, et al., 2000). There are two ways for final disposal, it could be by incineration or landfill (Stoyanov 2012). In the incineration case, it is possible to get energy during burning process, while the landfill way is completely unfavourable in the reverse logistics system. In addition, governments' restrictions forced the companies to reduce the space of landfill by increasing the taxes and charges especially on hazardous and toxic materials (Rogers and Tibben- Lembke, 1999).

2.5.3.5. Redistribution

Finally, the reconditioned and recovered product, materials and components are distributed again to the market where new customers could be attracted. Moreover, the redistribution process returns back the recovered product from the reverse flow system to the forward supply chain (Fleischmann, et al., 2000). There are many potential possibilities for redistribution and it could be determined as following; *sold as new, sold via outlets and discount stores, sold through a secondary market or donated to charity* (Rogers and Tibben-Lembke, 1999).

Chapter 3: Research Methodology

This chapter will give an explanation of how this study develops. It provides a systematic platform to the researcher to answer the initial research question which leads to the conclusion including research method, data collection, research design, and creditability.

3.1. Research Method

It is very important to distinguish between the qualitative and the quantitative approach to help in identifying the design of the research and how it can be carried out. A **qualitative method** is based on the interpretations of researcher and often depends on words and descriptions to create a deeper understanding of a specific area. Interviews and observations are examples of qualitative analysis. While the **quantitative method** is based on numerical and statistical data, it is a convenient approach to manage a large amount of data which can easily be presented in figures and tables. Since not everything can be measured in a numerical way, the qualitative approach sometimes needs to be applied.

The qualitative approach will be more suitable for this study insofar as it gives a comprehensive description of practical and theoretical reverse logistics' processes of the electronics sector and how a company can deal with its end of life product through using what is known as e-waste approach. In this thesis, the theory about reverse logistics and e-waste management is first studied and then the case is examined accordingly, which underlines the constant interplay between the theoretical framework and case study (Dubois & Gadde 2002, 559). The researcher then closely examines the topic from three important viewpoints: Why? How? And what?

- ✓ Why the international companies have not applied the globally e-waste programmes in the developing country?
- ✓ How the informal sector in developing countries deals with the electronic waste if there are no significance recycling network?
- ✓ What is the initial solution following the examples of developed countries to solve the e-waste problem in Egypt?

3.2. Induction, deduction and abduction

There are three approaches when making a research that describes the relationship between theory and empirical data. **Induction** is when data collection is started without any previous knowledge in the research area and no theoretical studies are made beforehand. **Deduction** is

the opposite of induction and the most common and structured research method are done before. While **abduction** uses both the inductive and deductive approaches. Since the analysis of the thesis is based on both theory and empirical data, it belongs to deduction research approach as the questions are connected to the main objectives of the study.

3.3. Data collection

There are two main techniques when collecting data. The first technique is collecting primary data and the other one is collecting secondary data. The primary data is collected directly by the researchers and it is valid and adjusted to the thesis but takes a long time to collect. On the other hand, the secondary data is data which has been discussed and collected by someone else and take less time to collect.

3.3.1. Secondary data

Secondary data are a good alternative to obtain the required information that contributes to the production of reliable answers to the proposed research questions and to build the literature review. Since this thesis tackles the reverse logistics in the electronics industry, the relevant information is found in websites, annual reports, books, governmental documents, previous studies, scholarly journals, articles and brochures which are done on reverse logistics and sustainable business strategies for e-waste management. The researcher has specified the search words[2] before searching for the secondary data.

3.3.2. Primary data

Since there is little relevant data regarding to the e-waste recycling programme of Samsung in Egypt, most of the information in the case study is obtained from Samsung's official website, annual sustainability reports, Samsung press, and electronic interview. The interview were contacted with Mr. George Seddik, head of corporate marketing in Samsung-Egypt by the internet through sending questions via e-mail, and some changes of wording were performed for a deeper explanation of some questions. In addition to the interviews which were conducted with Samsung, there are many semi-structured interview with Samsung certificated shops in Alexandria. The researcher conducted informal meetings, together with observations from

[2] The main keyword for this thesis are; reverse logistics, e-waste management, consumer electronic business, Samsung Electronics Company, and Egypt recycling network.

scavenger and garbage dealer to explore the fate of Samsung product. All collected data and information are transcribed and translated to English.

3.4. Research design

Exploratory search methods are important for innovative industries to determine their management and practices as well as develop their strategies. Given the fact that this thesis examines electronic industries; it is useful to resort to the exploratory search method. This method, thus, helps the researcher to closely examine the topic of the research by learning new information and discovering new relationships and patterns. In addition, it is flexible and adaptable enough to cope with any possible changes in the data (Hair, Money, Page and Samouel, 2007). **Descriptive** research, on the other hand, is designed to measure the characteristics of the phenomenon, the problem and the situation that are collected in the structured process, in terms of observations or interviews, which also makes it suitable for this research.

3.5. Creditability

Reliability concerns the trustworthiness of the study. In this study, the interviews have faced different kinds of problems which could have influenced on the research attempt in collecting correct data. It represented a true challenge for researcher to make the respondent understands the questions correctly. Thus, the researcher can ask the questions in different ways and different words to verify that the respondent understands the question, and accordingly can give a proper answer. This method mentioned above has been used throughout the interview process to reach to the highest percentage of reliability.

The **validity** is about finding out if the data collected is relevant to the problem. In this thesis the theoretical understanding of e-waste management is the same problem in the Samsung case study in Egypt, there is consistency between them. The researcher sees clear connection between the theoretical and practical principle of e-waste management and for this reason can say that there are valid data. The **objectivity** of the literature is considered to be high since multiple independent sources are used and the researcher does not have prior engagements within Samsung or any other connections which can decrease the objectivity of the study.

Chapter 4: Consumer Electronics Sector and the E-waste Management

This chapter starts by explaining the consumer electronic industry characteristics and its trend. Then, it will illustrate the e-waste definition and characteristics, and what is the practical solution which companies can use to be successful and overcome the e-waste challenges. It also focuses on the flow of e-waste around the world.

4.1. Consumer electronics industry

In the 20th century, the continuous innovations and changing market demands have transformed the electronics industry, especially consumer electronics, into a global industry that is worth billions of dollars, and made it the most competitive business around the world. Each year, the electronics consumer sector produces a huge numerous of products and services where all the members of contemporary society accustomed to use them daily even for communication, entertainment, and office efficiency. Furthermore, there is no other industry that can compete with the electronic industry in terms of the speed of the shrinking of product's life cycle, the fluctuation of supply and demand, rapid inventory depreciation, complex supply chain, multiple sources of supply and consumption, and the unexpected requirements from retailers and customers (Sinha, 2004).

The consumer electronics sector is the most dynamic, most fast changing sector in the world (Ettlie, 2006). Moreover, the consumer electronics manufacturers focused on the innovation of products design which achieve the balance between: the agility, the ability of the company to face the market changes; adaptability, the company's ability to adapt with new technologies and strategy; and alignment, which means the ability of the company to make its processes and systems keep up with changes, in order to increase their profit margins through cost reduction.

There are many consumer electronic brands which have a key factor in building the consumer electronic business such as; Sony, Toshiba, Samsung, Apple, Motorola, Dell, LG, Sharp and Philips. These brands have worked seriously over years to deliver strong quality electronic devices to their customers around the world. The main key in the consumer electronics business to get market propaganda is to inspire a leading technology or to be the first to use an exciting idea. Today, the consumer electronic market is witnessing an extraordinary evolution due to the increasing in the outstanding electronic devices which are available in the market. Since the customer's demands are higher than before, the company has to use creative technologies to stay in the market. Furthermore, most of companies now invest heavily into the Research

and development (R&D) sector to be sure that its products are technologically more advanced. They employ large numbers of electronics engineers and electronics technicians to design, develop, test, manufacture, install, and repair electrical and electronic devices.

4.1.1. Characteristics of consumer electronic market

The characteristics of the electronic industry, which set it apart from any other sector, can be summarized in the following points:

- Regular implementation of scientific research to continuously generate high level of innovativeness, domestic and international cooperation with other scientific and research centres for getting many of the patents and licenses (Drucker, 1985).
- High financial expenses for R&D activities, 8% and more of the sales value, and high investment risk.
- High level of employment of scientific and technical personnel to predict future and forward thinking and share knowledge as a team learning (Aydogan, 2009).
- High rotation level of technical equipment and replacement by more innovative devices (Ettlie, 2006).
- The main values of electronic industry are: quality, customer service, variety, innovativeness and partners' relationships.
- Long supply chain lead times and it requires tremendous coordination between design, manufacturing, distribution and transportation.
- Electronic industry needs global manufacturing and market base as it involves a wide range of products.

4.1.2. Value chain of Consumer electronics sector

The electronics supply chain is broad and complex. It includes a variety of participants ranging from raw material suppliers to end customers as each firm has its supply chain with small differences according to its social, technological, and environmental status. The main goal of supply chain management is to improve the coordination and flow of information, materials and financials in a way that benefits all participants involved. The supply chain management in any organization has to contribute to meeting growing consumer demands, reducing business

risk, and responding to increasing competition. In many industries, the ability to manage the supply chain activities determine the difference between successful and failure companies.

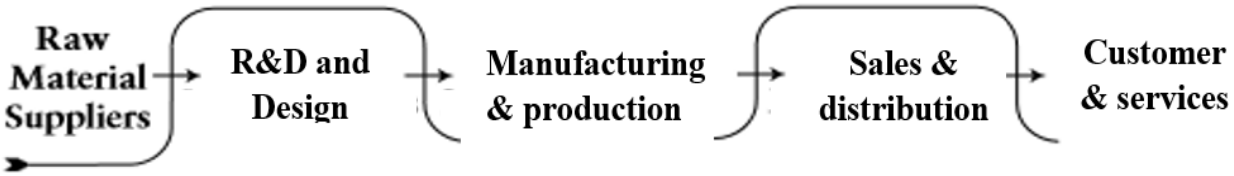


Figure 3: Basic supply chain of electronic industry (*Source*: adapted from U.S. Bancorp Piper Jaffray Equity Research – Electronics Manufacturing Supply Chain)

The previous figure illustrates the value chain of electronic sector, it is clear that the raw material sourcing is considered as a first step to get the basic raw materials such as plastics and metals to produce any electronic device. The next step is R&D and design form. As this sector is rapidly changing and the consumers' needs are renewable, many manufacturers focus on R&D activities because they help producers to developing more advanced and innovated devices, and to predict the customers' expectation in order to maintain their brand image.

In the manufacturing and production process, the design of products which are created in the R&D stage will be manufactured, examined, tested for quality and durability, packaged, and warehoused. The manufacturing and production stage is followed by the sales and distribution activities. The sales personnel are responsible for advertising and marketing for new products to get the highest percentage of sales, while the mission of the distribution process is to distribute the products through wide networks which involve the main distributors, wholesalers, and retailers. The last stage in the value chain of the consumer electronics industry is customer and after-sales services which are responsible to provide any service related to the products and assist customers in any inquiries, sometimes the responsibility extend to include the discarded devices.

4.1.3. Challenges in consumer electronic supply chain

The consumer electronics supply chain has faced - and is still facing - a variety of significant challenges:

Mass customization: The electronic market is characterised by the rapid development in components, systems, and technologies. In this sense, the customer demands on electronics devices is highly renewable and have strict requirements. So, companies have to continually produce new innovative products with low cost to meet the customers' expectations. Furthermore, there is an urgent need for electronics companies to create a supply chain which combines the functional benefits and cost-effective (Hvam, 2006).

Shrinking product life cycles: While electronic and electric products are included in commodity item list, producers have to manufacture new products regularly in order to maintain a large proportion of the profits and preserve market share. This strategy leads to make the products life cycles very short as some consumer electronics products have a life cycle of six months or less. Since data about products' life cycle are generally difficult to acquire, manufacturers have to use collaborative planning techniques where they can work very closely with retailers and resellers, and be closer to the end customer for sharing the products' details (Bayus, 1998). This will help producers to get an accurate data about sales' history for similar products, accordingly, getting better forecasting about the life cycle of their products.

Managing inventories subject to a rapid depreciation: the manufacturing components and semiconductors are providing high efficiency functionality at low price. Furthermore, the manufacturers bought and store them to gain cost advantages. The short product life cycle could led to rapid depreciation of these components and parts. However, manufacturers feel obliged to manage between using stored components and new ones and the company which can manage its inventories at the right time could achieve considerable benefits (Ernst, 1997).

Supply and demand misalignment: it is clear that the economic variation around the world causes fluctuations in customer demand accordingly in the production growth. The preferences of consumers can lead to an increase in demand for a specific product or company (Roberts, 2012). Although the difficulty of consumer electronics sector to keep inventory aligned with expected demand, the manufacturers try to use the collaborative planning techniques with supplier and retailers in order to know the time to market their products and to fulfil the demand.

Pressure from retailers and resellers: according to Hvam, (2006), there is a big strain on electronics' manufacturers due to the increasing pressure from retailers and resellers to provide new products exactly in the right time and place according to their expectation to avoid the huge cost of failed promotion. This issue is very difficult for manufacturers, hence they commit to communicate and collaborate with all members of the supply chain to fulfil the retailers' demand.

4.1.4. Consumer electronics sector trends

Although the global economic conditions are fluctuating, the global consumer electronics' revenue is expected to grow in the next years as customers' need also grow. The rapidly evolving global consumer electronics production is one of the most important characteristics

of this business. As electrical and electronic equipment (EEE) have become reasonably priced with new technologies, design, and function, the size of electronics sales has increased around the world (Singh and Siddique, 2012). The rapid growth in the usage of electrical and electronic devices around the world led to reduce the lifespan of devices and to make them obsolete faster. Accordingly, this created a large volume of discarded electronic products (Lin et al, 2002). These discarded products included computers, batteries, microwave, mobile phones, oven and other discarded devices. Therefore, the management of electronic waste has become a global concern in a globalised world to recover the appliance which has reached to its EoL (Kim et al, 2011).

4.2. Electric and Electronic waste management

E-waste management has become one of the most important issues among government organizations, environmentalist groups, private sector and manufacturers of consumer electronic devices. Traditionally, most of the electronics producers were not responsible for the products when they reached to their end of life and thus a large amount of used products, which were discarded, caused considerable damage to the environment (Liu, n. d). That is why waste management has got global increased attention.

In the last decades, the boom of technologies led to large quantities of electronic waste annually, which is creating huge disposal problems. Electrical and electronic wastes are the highest growing waste stream (about four per cent growth a year). Globally, it is expected that more than 72 million tons of e-waste were disposed of in 2014, while the global e-waste recycling rate is projected to increase from 13% to 18.4% between 2009 and 2014 (Jiang et al., 2012). Most of these devices contain a significant quantities of toxic metals and chemicals such as zinc, lead, aluminium, copper, silver, gold, platinum, etc. Hence, recovering such hazardous products requires an effective solution to prevent the leakage toxins into the environment (Luttropp and Johansson, 2010).

According to De Brito and Dekker (2003), waste management is the collection and processing of waste that has no longer any reuse potential. It is a major part of supply chain activities because it deals with reverse logistics processes. Since reverse logistics is an integral part of the e-waste management, the company which is able to manage its e-waste has the opportunities to cut costs and recapture lost revenue. But at the same time, the environmentally sound manner of recovering for the electronic devices is deemed a complex, expensive and dangerous process that is considered a challenge for companies and manufacturers.

4.2.1. E-waste definition

According to Porter (2002), "waste" refers to anything which reaches a point in time when the product is no longer privately valued by the initial customer. This definition is similar to the definition of "waste" by Brito and Dekker (2003) who claim that "waste" refers to commodities which have no longer any reuse possibilities. Regarding to their definition, it can be realized that the electronic waste is any end-of-life electronic product which has stopped to be of any value for its owner.

There is no standard definition for E-waste but a number of countries have come out with their own definitions. The most popular definitions illustrated two main points which are related to: the meaning of discarded equipment and what equipment the definition refers to. The most widely accepted definition of e-waste has been described as per EU directive 2002/96/EC and Basel Convention: "*electrical or electronic equipment, which is waste … including all components, subassemblies and consumables, which are part of the product at the time of discarding*" (European Commission, n. d.(a)).

According to the Basel Action Network (BAN) the electronic waste "*encompasses a broad and growing range of electronic devices ranging from large household devices such as refrigerators, air conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users*" (Puckett and Smith, 2002, P.5). Similarly, The Organisation for Economic Cooperation and Development (OECD, 2001) defines e-waste as "a*ny appliance using an electric power supply that has reached its end-of-life*" (UNEP, DTIE, 2007a).

In addition, Solving the E-waste Problem (StEP 2005) points out that the term of e-waste was used to refer to "*The reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers, recycles, or otherwise processes waste*". However, the absence of a specific definition of e-waste is one of the important issues which need to be classified at the international level. It is important to have a specific definition for e-waste because it can make a significant disparities in the new generation of e-waste quantity and e-waste flows. In addition, it can assist the policymakers and stakeholders in identifying the legislations which can be adjusted during the handling process of electronic and hazardous waste (UNEP, DTIE, 2007a.). The electronic waste definition which will be used throughout this thesis is '*an electrically powered appliance that no longer satisfies the current owner for its original purpose but can be reused or recycled into a new product*' (Sinha, 2004).

4.2.2. Reason for recycling E-waste

The end-of-life products may not be very useful to their owners and they need to be disposed. The electronic waste is considered one of the most dangerous and fastest waste in the waste streams list (EEB, 2001). E-waste management is not just represented in disposal or recovering but also encompasses the pre-disposal process which is illustrated in reverse logistics activities including collecting and transporting processes. The main reasons for recovering the e-waste are to reduce the growing e-waste problem through 4R strategies 'Reduce, Recover, Reuse and Recycle', reduce the amount of greenhouse gas emissions, avoid air and water pollution, and minimize the dangers to human health and the environment. As well as, Sinha (2004) emphasizes on three aspects which make the companies concerned about the management of e-waste:

Economic factor

This process presents a threat as much as it presents an opportunity. Despite the difficulty of products' composition, it contains valuable metal/components and hundreds of other materials. New recycling techniques and technologies are able to achieve high rates of recovered metals; almost 95-99% can be achieved (Sinha, 2004). According to Lindhqvis (2000), the e-waste is an important source which should to be recovered, especially as raw materials' prices are increasing continuously.

Environmental Factors

One of the main reasons for concerning the e- waste management is the absolute neglect and sub-optimal use of hazardous substances which influence health and environment. In this sense, the wrong disposal such as dump or incineration can be extremely affected the plant and people through emissions and effluents from the processing.

Data security factors

Privacy protection is an important concern for the company to recover their discarded equipment. They have supported the process of e-waste recycling but it is necessary that all the confidential and personal data are destroyed completely to be sure of the safety of organizations and individuals' information (Sinha (2004).

4.2.3. E-waste characteristics

E-waste has some unique characteristics which require special steps to manage. The value of e-waste can be functional or material value. Electronic devices can be waste for its owner because of new features, economic changes, higher costs of repair, and technical or aesthetic obsolescence (Sinha, 2004). The following figure shows the various value level of EEE waste. Ideally, in the first three levels, the electronic products have a functional value which they can get through repairing process. While in the last level, the product loses its function and cannot be repaired hence, it can be disassembled to reuse the good components or parts. It is clear that there is an inverse relationship between the duration of using EEE and obtaining value: the more percentage of product utilization, the less functional value is obtained

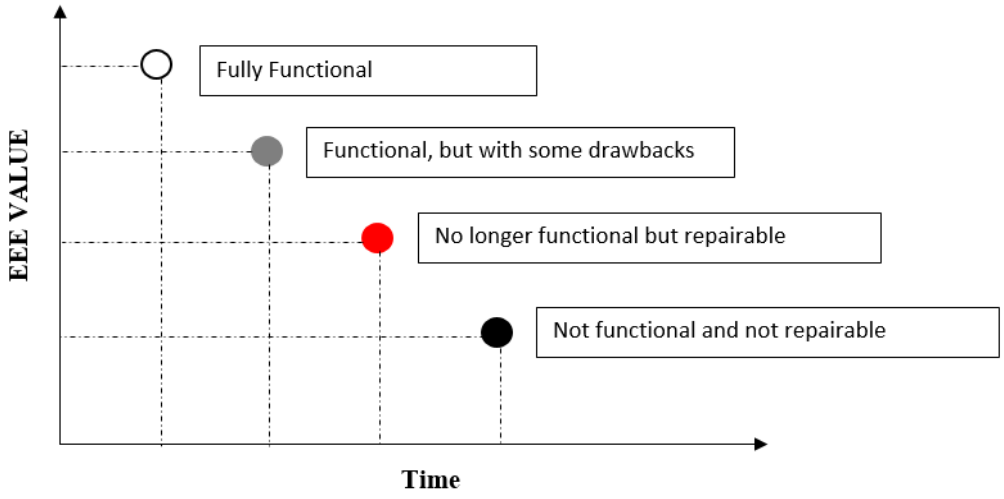


Figure 4: Stage of value of EEE (*Source*: adapted from Sinha, 2004)

According to Gregory et al. (2009), the characteristics of e-waste are represented in the following points;

- With raising incomes and falling prices of electronics, more customers will be able to purchase electronics and accordingly the **large quantities** of e-waste will be generated.
- E-waste is considered **highly toxic,** especially the components and parts which contain banned substances. There are some products which are not toxic in themselves, but when they are recycled or in an incinerator, they generate hazardous dioxins and furans.
- It is difficult to predict the flow of e-waste quantity because the **unpredictable time lags** from the time when a product is sold to the time when a product is turned into waste. According to Matthews et al. (1997), the reason behind the difficulty of estimating e-waste flows is the completely different paths for products before the final disposal. It could be reused or stored in basements and attics by customers.

- The waste of electronics could **contain valuable and rare materials** such as gold, palladium etc.
- The **variation in composition and contamination** makes the recovered products in a losing competition with virgin materials.

4.2.4. Practical solution for handling e-waste problem

The fast increasing load of e-waste has led to a need for an insistent intervention through waste reduction and to use some strategies to reduce the environmental pollution of the present management practices for EoL EEE (Osibanjo, O. and Nnorom, I.C., 2007). The appropriate strategy is determined according to the product characteristics which result in the minimal damage to the environment and the maximum reusability. As well as, *cost, labor availability, return flow volume, and optimal disassembly level* determine the most suitable process for recovery (Ritchey et al, 2001). According to King et al. (2006), the practical solution for recovering e-waste can be summarized in the following figure; *dump, recycled, remanufactured, reconditioned, and repaired*.

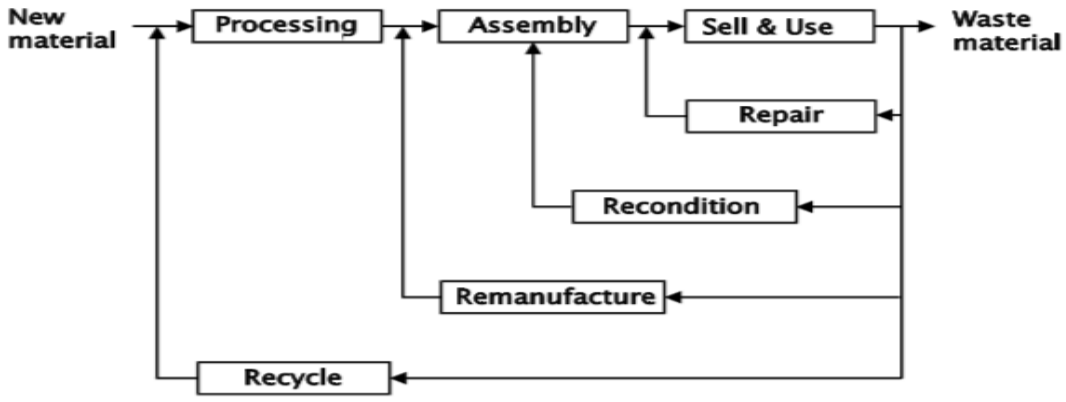


Figure 5: practical options for end of life electronic products (*Source*: King et al., 2006)

Dumps

Electronic waste is often disposed in special sites for hazardous waste, but there are some barriers which make hazardous waste landfill unpractical; hazardous waste dumps are too expensive compared with ordinary landfill, the space and number of hazardous landfills are limited, and they are not available in all places (Niu & Li, 2007).

Recycling

Environmental Protection Agency (EPA) adopted National Recycling Coalition definition to define Recycling as "*the series of activities by which discarded materials are collected, sorted, processed, and converted into raw materials and used in the production of new products*" (NRC, 1999). Although recycling materials is the most mature waste avoidance strategy for the environment instead of take them to a landfill site, many designers hesitate to use the recycled components due to uncertainty in performance and quality standards (Chick, A. & Micklethwaite, P. 2002). Nonetheless, from another point of view, buying recycled products provide immediate savings as these materials cheaper than virgin counterpart.

In order to obtain the highest possible result, the discarded devices are completely disassembled and separated into various parts, these materials are usually shredded into an unsophisticated mechanical separator, with examination and granulating machines to separate metal, plastic or glass that can then be sold to smelter or plastics recyclers. All the components are tested and inspected to evaluate their performance in order to determine the level of maintenance. If the parts do not need any maintenance, they are organized for reassembling as follows: they are inspected, cleaned, refurbished, improved, upgraded and sent to the stocking space, whereas the parts which need maintenance are transported to the repair area depending on their defects.

Remanufacturing

The remanufacturing process includes many substantial action to produce products that have the same or similar performance and quality standards as new units or meet the Original Equipment Manufacturer (OEM) functionality and reliability specifications. This process occurs using either the previous components which have been taken from electronic waste or the new components, if needed. (Gregory et al, 2009). Remanufactured products requires performing necessary operations such as; disassembly, overhauling, testing and replacement the defect components which do not match the standard specification by new ones (K. Nakashima, 2006). Furthermore, the process of product restructuring until it becomes as new is known as remanufacturing. The quality performance of remanufactured product should be equal to that of a new equivalent, but the energy which is required to produce a new product is significantly lower (Song, et al, 2005).

The remanufacturing operations need smaller capital investments than manufacturing operations, their costs are typically 40 to 65 percent less than the new products (Giutini and

Gaudette, 2003). This is because most of the raw materials have already been done before by the OEM and only few processes need new parts.

Reconditioning

Reconditioning includes less work compared with remanufacturing, but more than that of repairing. Recondition requires the rebuilding of a significant number of the core components of an electronic device, and it is expected that the reconditioned goods are inferior to the new goods. All defected or broken components/parts would be replaced or repaired, even if the customer does not notice the fault in these components. The refurbished electronic products are not consider new products and therefore do not provide the latest functionality, but their cost could be less than 50% of the cost of new ones (Isabelle and Gutowski, 2013). Additionally, the reconditioned electronic devices have a less performance specification and associated warranty compared with the new product (DARP, 2003). It is clear that the reconditioned product has been recovered to extend its functional life and to be fit for reuse, but at the same time it does not back to its virgin condition.

Repairing

Repairing is one of the best methods to handle e-waste because the product needs a simple service and repair in order to extend its life. Repairing is not a complicated process, because it is characterized by an easy correction of a specified error in a product's components. On the other hand, the quality performance of repaired products is usually less than remanufactured and reconditioned products. Furthermore, the warranty of repaired products may not include the whole product and it only covers the replaced parts. Sometimes the cost of repairing electronic product is too high when compared to purchase a new product.

4.2.5. Challenges and barriers in E-waste management

There are different barriers and challenges to managing the global e-waste crises, the following points show some of the main issues posed by the e-waste problem:

Increasing the volume generated: rapid obsolescence of devices combined with the fast demand for new technology is one of the main reasons which leads to generate high volumes of e-waste (Basel Action Network [BAN], 2011). In addition, the increasing focus on forward supply chain while giving no considerable significance to returns could cause inflation in e-

waste problems. Moreover, companies have to know that reverse logistics is a key part for maximizing value through returns (El-Nakib, 2012)

Limited Forecasting and Planning: collecting and moving e-waste to a recovering facility is one of the huge obstacles in managing the waste problem because of the insufficiency of accurate return forecasts. Most products do not disposed immediately, but are stored aimlessly. This led to decreasing the opportunity of recovering their value (Lindhqvist, 2000). Lack of infrastructure can also be a significant obstacle to implementing an effective management of e-waste, especially if the collection and recycling infrastructure is not able to be compatible with the increasing volumes of waste.

Poor design and complexity of electronics: as electronic devices are made up of various material which are mixed, bolted, screwed, snapped, glued or soldered together, it is difficult to recover them. Hence, the responsibility of recycling needs intensive labour, as well as advanced and costly technologies that safely separate materials (BAN, 2011). It is better to take the equipment design issue into consideration during the production process because the product design influence the recovering and dismantle processes.

Lack of authoritative data is also consider a big challenge for policymakers and stakeholders who design a strategy for e-waste management. There is a lack of reliable data concerning the undefined life cycle of some products, which in some cases extend to several years. Furthermore, it is very hard to estimate when the product would be waste. Also, there is not enough information about the treatment techniques of the potential hazards which exist in many electronic devices.

Lack of regulation to address e-waste problem: most developing nations do not have adequate regulations to address all these electronic waste or fail to implement effectively such regulations (BAN, 2011). Some countries such as U.S.A, Canada, and Japan feel free in trading the hazardous e-waste despite the 1989 Basel Convention[3], as they pass their responsibilities, risks and hazards to the developing countries. They strongly oppose the Basel convention to maximize their profit, even if they violate the laws of importing countries (Puckett and Smith, 2002). The transboundary movements of e-waste is contrary to the principle of environmental justice because most of receiving countries do not have the ability to recover the waste in the

[3] It is the first international agreement to reduce the amount of hazardous waste generated and, prevent the movement of e-waste to developing countries. It was adopted in 22 March 1989 and entered into force on 5th may 1992, 180 states and the EU are parties to the convention, the United States is the only developed country which has signed but not ratified it.

right way (BAN, 2011). It is estimated that 50% to 80% of e-waste will be shipped from developed countries to developing countries in 2014 (Wang et al., 2013). As well as, prison laborers employed to process e-waste is one of the most prominent forms of rules violation[4].

Informal and illegal disposal of e-waste: the cost of managing electronic waste is very high comparing with the low cost of landfill disposal. This cause a negative public perception for workers' and collector health and the environment during sending e-waste to developing countries that have inappropriate health and safety technique. According to Lundgren (2012), 80 percent of e-waste is being shipped (often illegally) to developing countries to be recycled by hundreds of thousands of informal workers and such globalization of e-waste has adverse environmental and health implications. In addition, the large number of '*orphan products*' without brand owner is one of the most important obstacles in managing e-waste because there is no specific organization which held the responsibility for recovery. In this scene, the technology of managing e-waste should be made available to developing countries, especially the global e-waste hotspots.[5]

4.2.6. Scale and international flow of e-waste

As shown in figure 6, the life cycle of electronic products usually passes through specific stages; production/manufacturing, sales (whether to individual households, private businesses, governments or other), consumption followed by generating the waste, trading the waste through scrap dealers (importing or exporting), treatment by disassemblers/dismantlers, smelters and recyclers, and the final stage is disposal of the e-waste in the landfill (UNEP, DTIE, 2007a).

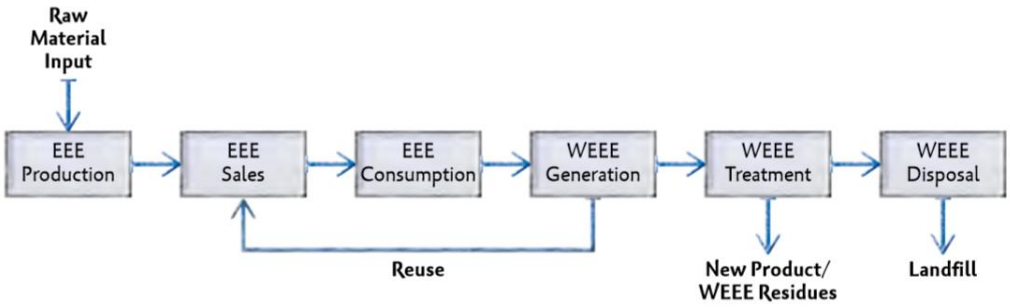


Figure 6: Life Cycle of electronic products waste (*Source*: UNEP, DTIE, 2007a)

[4] Some countries send its hazardous e-waste to the prisons for handling without any consideration for worker protections or the environments (e-Stewards official website).

[5] The areas on the planet that have been most influenced by electronic waste such as; China (Guiyu City), Africa (Nigeria, Ivory Coast, and Ghana), India (New Delhi, Mumbai, Chennai and Ahmadabad) and Karachi in Pakistan (Brigden et al. 2005).

Generally, the developed countries deal with e-waste in one of the following ways (Puckett et al. 2002, pp 6-8): put into storage and awaiting disposal, sent to landfill or incinerated, reused, either second-hand or refurbished, recycled at recycling facilities in the country of consumption, recycled in prisons or exported to developing countries. The most common and widely legal regulations are founded in Western Europe. Norway and Denmark are pioneers in the reverse logistics respect, both countries operate successfully reverse systems for recycling and reusing the beverage containers (Jayaraman et al., 2003). Netherlands and Germany are other familiar examples in this respect. Netherlands is responsible for implementing success system for recycling the end-life vehicles, and Germany has strict environmental regulations today which are connected to retail stores to force them to focus more on reverse logistics by disposing packaging materials (Cairncross, 1992). In this respect, most European countries are subjected to the European Union legislation regarding the treatment of wastes from electrical and electronic equipment, end-of-life vehicles, batteries and accumulators. Further, the European Union (EU) achieved the highest rates of e-waste recycling, followed by Japan (Lundgren, 2012).

Although there are no sufficient data available for the national statistics organizations to be able to gather information about how much e-waste is generated and where it is moving to (SAICM, 2009), the next figure illustrates the major sources and destination of e-waste, China and India are surrounded by many of the e-waste exporters. They receive huge amount of e-waste coming from Australia, Japan, South Korea, and Eastern Europe. In 2007, the United Nations Environment Programme (UNEP) estimated that 50 million of electronic waste is annually generated worldwide, and that China will receive the largest percentage of e-waste with approximately 70 per cent and above (Ni & Zeng, 2009).

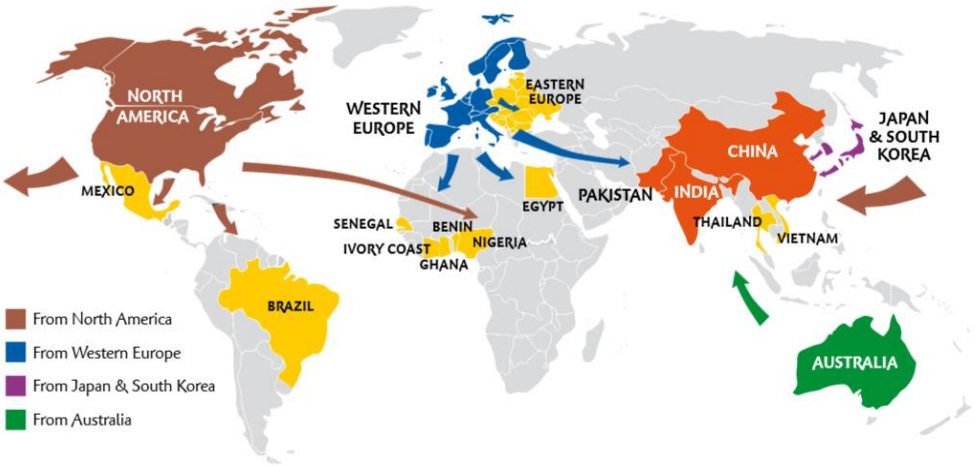


Figure 7: Export of e-waste (*Source*: Lewis, 2011)

According to Basel Convention, West-Africa is the smallest area which receives e-waste, while the South-East Asia is the largest recipient for e-waste. It is estimated that West Africa will become the most common destination for e-waste in the future due to the remarkable growing of e-waste and the stricter policies in Asia. The next map try to illustrate the known sources of e-waste, known destinations and suspected destinations for e-waste dumping. This figure derives its information from global organizations such as; Basel Action Network, Silicon Valley Toxics Coalition, Toxics Link India, SCOPE (in Pakistan), Greenpeace and others.

Figure 8: Known and suspected routes of e-waste dumping (*Source*: Lundgren, 2012; University of Northampton, n. d.)

Chapter 5: Regulations of e-waste management (Europe Union directive and Arab Area regulation)

This chapter will focus on the regional context for e-waste management describing the e-waste policies in Europe which boast high recycling rates by using the EPR (Extended Producer Responsibility) concept and the Arab region as developing area. This section will illustrate the agreements, rules and obligations of each area.

5.1. E-waste policy in Europe Union

Increased economic growth has been the principal cause for the increase in production which has led to increasing consumption and thus increasing waste. In developed countries, there are significant recovery facilities and policies that are specifically designed to manage toxic materials, and recover precious and heavy metals which are found in electronic waste (Maxianova, 2008). The EU is known for having the most advanced electronic waste laws and legislations in the world. These directives work in tandem to reduce the e-waste at all stages of its life cycle and accordingly the EU has the greatest "*absolute volume*" of e-waste recycled yearly. The EU will seek to recycle at least 85% of electrical and electronics waste equipment by 2016 (Zoeteman, Krikke, & Vensellar, 2010).

The directives which will be discussed in this section are; limiting of hazardous chemical use in the Restriction of Hazardous Substances directive (RoHS), Waste Electronic and Electrical Equipment (WEEE) directive which includes the principle of EPR, and Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

5.1.1. Restriction of Hazardous Substances Directive (RoHS)

RoHS is short for "Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment". It was adopted in February 2003 by the EU. The RoHS directive took effect on 1st July, 2006, and each EU member state is adopting its own enforcement and implementation policies using the directive as a guide (European Commission official website). It is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC. RoHS aims to prevent the high volume of e-waste, reduce the hazardous materials in the electronic equipment, and create an efficient recycling system to solve the issue of electronics waste.

In addition, RoHS Directive bans the placing of new electrical and electronic equipment containing more than the agreed levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl and polybrominated diphenyl ether flame retardants to its market. The RoHS 2 directive (2011/65/EU)[6] is an evolution of the original directive, and became law on 20th July, 2011 and took effect 2nd January, 2013. It addresses the same substances as the original directive while improving regulatory conditions and legal clarity (Official Journal of the European Union).

5.1.2. Waste Electrical and Electronic Equipment Directive (WEEE)

The Waste Electrical and Electronic Equipment Directive (WEEE) is the European Community directive 2002/96/EC which works in tandem with the RoHS Directive 2002/95/EC, became European Law in 13th February, 2003. The law imposes take-back obligations on manufacturers and importers of electrical and electronic products. Importers and manufacturers are responsible for the take-back system and recycling the discarded products. These directives are not pointed directly to manufacturers, but the national law in each jurisdiction organizes and regulates the responsibilities and obligations of manufacturers, authorities, distributors and all other actors.

The WEEE directive set collection, recycling and recovery targets for all types of electrical goods, with a minimum rate of four kilograms per head of population per annum recovered for recycling by 2009. The categories which are defined by a section of the WEEE directive to be applied are: large household appliances, small household appliances, IT and telecommunications equipment (although infrastructure equipment is exempt in some countries), consumer equipment, lighting equipment including light bulbs, electronic and electrical tools (discarded computers, office electronic equipment, entertainment device electronics, mobile phones, television sets, and refrigerators which are destined for reuse, resale, salvage, recycling, or disposal), toys, leisure, and sports equipment, medical devices (exemption removed in July 2011), monitoring and control instruments (exemption removed in July 2011), automatic dispensers, and semiconductor devices.

[6] EU directives are usually updated and re-evaluated to facilitate the gradual broadening of its requirements to cover the new electronic and electrical equipment.

The main objectives of the WEEE directive are: reducing the waste arising from end-of-life EEE, maximising the recycling rate, improving the other forms of e-waste recovery, and minimising the impact on the environment from the treatment and disposal processes.

The directive imposes the responsibility of e-waste disposal on the manufacturers or distributors. It requires a good infrastructure for collecting the e-waste, in such a way that users can return the discarded products free of charge under the principle of EPR. This principle is an integral part of the WEEE where the company should take the disposal process into consideration because they are considered as a part of the product life cycle (Nakajima & Vanderburg, 2005). As a result, the producers must be keen to design products that are characterized by ease of recycling (Castell, Clift, & France, 2004) to mitigate any possible hazardous waste arising from their disposal. The EU governments have allocated a financial support in order to encourage producer to follow e-waste legislation and eliminate e-waste dumping (Zoeteman, Krikke, & Venselaar, 2010, p. 422).

5.1.3. Registration, Evaluation, Authorizations and Restriction of Chemicals (REACH)

REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals. It entered into force on 1st June, 2007, and it adopted to ensure a high level of protection of the human health and the environment from the risks which can be posed by chemicals industry (European Commission official website). REACH regulation makes the industries responsible for their risk by providing suitable safety management. It is not only applies on the chemical industry, it also includes other industries which may not consider themselves involved with chemicals such as: cleaning products sector, painting companies, furniture and electrical appliances. Further, this regulation covered most companies across the EU. All these companies need to register their substances then, the REACH evaluates the properties of hazardous substance to know the initial impact on people and environment. Authorities can ban some hazardous substance if the risks are unmanageable (European Chemical Agency official website).

5.2. E-waste policy in Arab Region

The electronic industry and communication technologies have gained a great concern in the Arab region during the last two decades. This concern causes flourishing in the social and economic conditions in the Arab area. Accordingly, the quantity of electronic waste has increased, leading to raise the alarm signals because the Arab region consists of 22 countries and territories with a combined population of some 362 million people spanning two continents (World Bank, 2014). The efforts for recovering the e-waste in this area have been very limited and restricted to random and small-scale initiatives and it is still considered as an untapped chance to gain the benefits. The absence of appropriate techniques for managing electronic waste in the Arab states, will contribute to increasing the toxic emissions to the air, water and soil. This problem also provides an illegal job for those who do not have formal work. As a consequence, it will cause major health, environmental and developmental challenges for the region.

According to Allam (2009), 300 questionnaires were sent to NGOs, private enterprise, governmental organizations, and Information and Communication Technology (ICT) companies of the Arab region. The received answers showed that there is no official sector for e-waste management. This is because most of these organizations did not recognize e-waste as a key issue in their environmental program or strategy. Therefore, they did not implement any activity related to e-waste handling issue. Despite this general complacency of the movement of e-waste management in this area, there is some private participation which offers good initiatives to the careless environment customers to bring back their old devices to recycling companies, whereas more educated people are more cooperative to find a way to the recycling centre without any initiatives. Allam (2010) clarify that the private sector enterprises are active in Egypt and the United Arab Emirates (UAE) supporting the collection of used mobile phones and batteries. Bahrain has, together with Saudi Arabia, the most advanced laws which help in regulating the e-waste in the region.

Since 2010, the Arab area has been lagging to achieve some tangible targets related to the e-waste issue because the political, economic and social transitions. However, the private sector, governmental organization, NGOs, and ICT companies of Arab region should cooperate to establish a legal framework related to safe e-waste management as this sector needs more investment and management processes than are presently available.

Unfortunately, there are no comprehensive databases or accurate information about the amounts and types of hazardous wastes which are generated in the Arab Region (ESCWA, 2007). Because there are not any Treatment, Storage and Disposal Facilities (TSDF) of hazardous wastes in the Arab area further, they depend on uncontrolled dumping or burning. There are some TSDF exist in the Gulf Cooperation Council (GCC) countries. However, though those facilities are available, they are inappropriate to handle the large volume of waste produced in the Arab Region as a whole (Al-Yousfi, 2008).

There are no united rules for the Arab area for handling e-waste such as the legal framework of the EU in the format of the WEEE and RoHS directives. Moreover, global organizations are being obliged to create some initial projects and activities to support this area in managing its waste, taking the WEEE and RoHS directives as a guidelines. Further, the following part will illustrate the role that international, regional, sub-regional, and non-governmental organizations play in the formulation and implementation of sustainable development plans in the Arab Region.

5.2.1. Basel Convention Regional and Coordinating Centers (BCRCs)

As shown in the figure below, the secretariat of the International Basel Convention created fourteen regional centres around the world to support the countries to implement the environmentally policies of Basel Convention and its amendments. These regional centres are considered as a focal point of implementing the Basel Convention's strategic plan and policy priorities. These centres help Basel convention to adapt its objectives regarding the different regional policies. The role of the Regional Centre of Basel Convention is represented in; delivering technology and training to reduce waste hazardous, dissemination of information, consulting, awareness raising about industrial and electronic wastes, mechanisms for environmentally sound management. They offer effective way for assessment, reporting, closer monitoring, and overseeing the e-waste management systems in the countries they serve (Basel Convention official website). The Basel convention takes a decision to establish regional centres according to the requirements of the region for training and technology which are related to handling hazardous waste and other wastes. As there is no regional policy or legislation for e-waste in the Arab area, the BCRC established the first centre in the Arab region in Cairo in 1998 to serve 22 Arab countries in Africa and West Asia in addition to Iraq and Palestinian Authority.

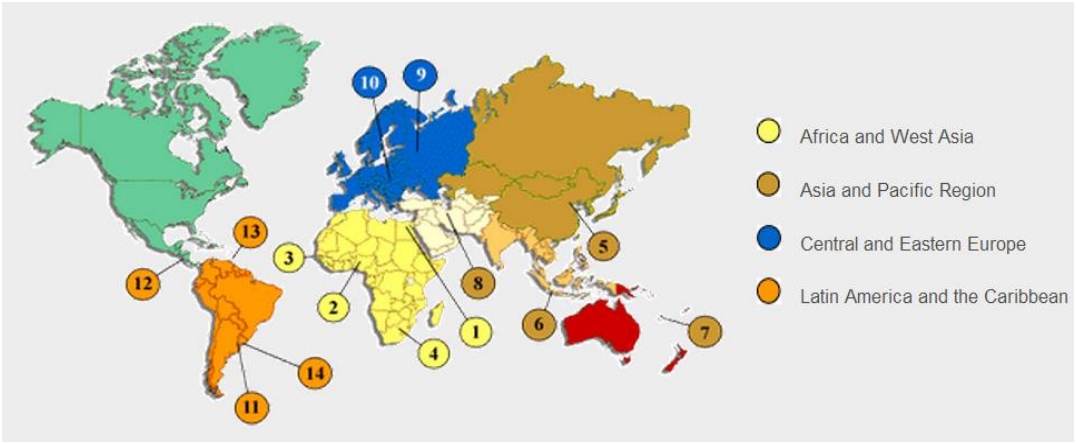


Figure 9: Basel convention regional and coordinating centres directors (*Source*: Basel Convention official website)

According to Kamel (2013), the regional centre supports the region to embrace with e-waste management through several activities represented in;

- Offering training in environmentally sound management, more than 17 training workshops and 15 pilot projects.
- Developed, and published the guidelines of best practices for e-waste management, the sanitary landfills, used liquid hazardous waste, and the appropriate way for conducting hazardous waste.
- Translated the guidelines of using the end-of-life mobile phones, which are prepared by the Mobile Phones Partnership Initiative (MPPI).
- Regularly publishing a biannual newsletter to promote the public awareness and discuss the emerging hazardous waste problem.
- Cooperating with regional organizations such as; UNEP/MAP, UNEP/ROWA, CEDARE, and RAC/CP of Barcelona, in implementing its activities.
- BCRC-Egypt is actively participating with other BCRCs, UN bodies, and Regional Organizations to transfer and share information and technologies between the members
- Supporting public/private sector to start offering small initiatives to handle the e-waste problem (Basel Convention official website).

5.2.2. Centre for Environment and development for the Arab Region and Europe (CEDARE)

The Centre for Environment and Development for the Arab Region and Europe (CEDARE) was established in 1992 as an international inter-governmental organization with a diplomatic status. It has begun to look at e-waste as well as climate change concerns (CEDARE official website). The Centre's mission is to provide leadership and advocate sound governance for environmental protection through; building human resources and institutional capacity, advancing applied research and environmentally friendly technologies, and acting as a catalyst to enhance collaborative action between the Arab World, Europe and the International Community. According to CEDARE official website, they are dedicated to cooperating with Information and Communication Technologies for Development (ICTD) unit to deliver projects in the following areas:

- Delivering more information about environment issues in Arabic through e-learning programme.
- Cooperating with global organizations to establish thematic networks hubs for the environment and development.
- Promoting best practices to deal with the environment.
- Enhance information dissemination mechanisms about protected areas in member countries.

CEDARE realized that solving environmental problems contributes to eliminating many development problems. Thus, the centre conducted many awareness campaigns to increase the understanding of the environmental issues. It manages a few research groups which can help the developing countries to adapt with environmental and development issues (Khordagui, 2004). Some of these initiatives can spread, enhance, and promote the modern concept of "*Environment for Development*" (CEDARE official website). In 2010, CEDARE conducted a regional benchmarking for Arab region regarding e-waste legal framework in order to provide as much information as possible. The CEDARE benchmarking is detailed in the following table:

Table 3: CEDARE Benchmarking of E-waste management in Arab countries

	Legal Framework	Inventory	Collection	Recycling & Reusing Technology
Level 1 – LOW	No legal framework, strategy, or norms	There is no inventory	There is no collection	There is no recycling/ reusing mechanism
	Iraq, Kuwait, Lebanon*, Syria, Yemen	**Egypt, Iraq, Jordan, Lebanon*, Kuwait**	**Egypt, Iraq, Jordan, Lebanon*, Yemen**	**Iraq, Kuwait, Syria, UAE*, Yemen**
Level 2	There is only plan to develop legal framework	There is the inventory for municipal solid waste, but no designated inventory for E-waste.	E-waste is locally collected by local recyclers, scavengers, etc. without any legal framework. Only recyclable E-waste is well collected	Only recyclable and reusable E-waste is recycled and reused by local stakeholders
	Bahrain, Egypt, Syria	**Bahrain, Syria, UAE*, Yemen**	**Kuwait, Syria, UAE***	**Jordan**
Level 3	A legal framework is being prepared and will be issued/enforced in very near future	E-waste inventory is being prepared	E-waste is well collected by local collection mechanism. Pilot separation and collection systems have been setup	There is a plan to set up E-waste facility
	Jordan, Tunisia*, UAE*		**Tunisia***	**Bahrain, Egypt**
Level 4	Enforcement, but the legal framework is not well conducted	E-waste inventory is conducted, but lack of information and data	Collection system for E-waste is operational and includes environmentally sound disposal	There is E-waste Recycling facility, but not achieve to full operation for all E-waste in the country
		Morocco*, Tunisia	**Bahrain**	
Level 5 – HIGH	Full enforcement and model legal framework for other countries	E-waste inventory is fully conducted and available on website	Collection systems are fully operational. Our collection is recognized as a model system by other countries	E-waste recycling facility is fully operated for all E-waste in the country and the model as the stat oft the-art recycling facility
				Tunisia*

Source: Allam, 2010

This table shows five levels of the e-waste management development sorted from worst to best. These levels can help in determining the performance of each country in the e-waste management in terms of the existence of legal framework, the ability to manage the e-waste inventory, the presence of collecting network, and the availability of recycling facilities. It is clear that most of the Arab countries in late stages towards the management of e-waste. They have not yet well known the effect of inappropriate e-waste management on the environment and the awareness is still low.

5.2.3. GIZ/SWEEP-Net

The project "Regional Network for Integrated Solid Waste Management (SWEEP-Net)" started in September 2009 and will continue for a second phase until August 2015. It is commissioned by German Federal Ministry for Economic Cooperation and Development (BMZ). The network secretariat is located in Tunisia and hosted by the Tunisian government

through the National Waste Management Agency "ANGed". Ten countries from the Mashreq and Maghreb region (*Algeria, Egypt, Jordan, Lebanon, Syria, Mauritania, Morocco, Palestinian Territory, Tunisia and Yemen*) have joined the network since the beginning. The activities with Syria are currently suspended because of the present situation[7] (SWEEP-Net official website). This project aims to establish a legal framework for e-waste to its members to ensure the continuity and sustainability of the network.

Seitz (2014) clarify that the project promotes the development and implementation of integrated solid waste management in the Mashreq and Maghreb region through the following points:

- Facilitating exchange and sharing of information experiences, and knowledge using an intelligent mix of communication means. Also, sharing the technology and information among its members to support each other's work
- Providing policy support for sustainable and integrated solid waste management and promoting the successful application of policies, planning tools, financing mechanisms, and technologies that are environmentally sound, socially acceptable, and economically viable.

According to Kamel (2010), the next figure shows the Middle East waste generation in the SWEEP-Net member in 2009. It is clear that Egypt stands alone by (40%) followed by Algeria (19%) and Morocco (17%).

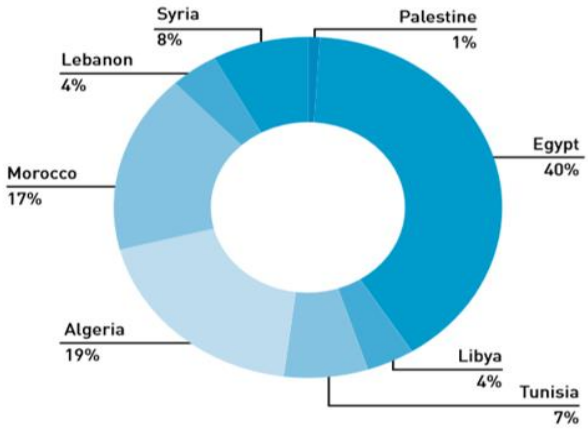


Figure 10: ME-waste generation in eight SWEEP-Net member countries for 2009 (*Source*: Kamel M. H. 2010

[7] Syrian revolution since 15 March 2011

Further, SWEEP-Net has been created a model to use it as a benchmarking for its members regarding to e-waste. This can help the project to know the differentiation reason of the generating e-waste volume in each country. The following table illustrates the results of each country regarding to the e-waste processes in form of regional benchmarking. It can be slightly differ from the result of the CEDARE study.

Table 4: Benchmarking of SWEEP-Net member countries

Criteria	Mauritania	Morocco	Algeria	Tunisia	Egypt	Lebanon	Syria	Jordan	Palestinian Territory	Yemen
General Data availability										
E-waste assessment										
Formal E-waste collection										
Formal and environmentally sound recycling										
Formal E-waste Refurbishing										
Policies and framework										
Local initiatives										
International cooperation activities										

The results have been evaluated in accordance to three levels:

Evaluation
Not available /Not existing
In Preparation / Preliminary activities
Available / Existing

Source: SWEEP-Net report, 2014

There are other efforts by several international institutions which focus generally on the regional environment such as; United Nations Development Programme in the Arab States (UNDP), The Global e-Sustainability Initiative (GeSI), Solving the E-waste Problem (StEP), UNESCO, and International Telecommunication Union (ITU) Regional Office for the Arab Region.

In a nutshell, there is an obvious lack of a comprehensive regional e-waste strategy and much to be done at the national level. The institution initiatives, which are cited above, are a just start. More comprehensive, strict e-waste management strategies, and implementation plans are needed on the national level more than the regional initiatives offer. However, raising public awareness should be a key element of starting E-waste management system through education campaigns including information about health and safety procedures. On the other hand, the companies and governments have to cooperate to solve the e-waste problem and find appropriate standards.

Chapter 6: Samsung Electronics Company in Egypt

This chapter will be divided into two sub-chapters, the first part will investigate some information about Samsung as a leading company in the electronics sector and what its value chain. It will also explain the trend of Samsung to handle its e-wastes globally and in Egypt. The second part will discuss the fate of Samsung devices in Egypt and gives a detailed description of Egyptian recycling network to manage the EoL electronic including Samsung equipment.

6.1. Samsung Electronics Company

6.1.1. History of Samsung group

Samsung Group was established in March 1938 by Lee Byung-chul in Korea as a trading company with a capital of only 30,000 WON[8]. The primary products, in this period, were fish, fruits, and vegetables, traded from Beijing and Manchuria. In 1958, Samsung become involved in different areas, including food processing, textiles, insurance industry, security and retail. In the late 1960s, Samsung group engaged with various investments in electronic and chemical industries, and consolidated its manufacturing base by adding paper and fertilizer businesses. In 1970, the company's strengths represented in the semi-conductor, information and telecommunication industries. The group also took a meaningful step toward heavy industry by venturing into aircraft manufacturing and shipbuilding. In the 1980s, Samsung group expanded its business and began building facilities offices in the UK, the US and Portugal (Samsung official website). In 1987, the son of Lee Byung-chul become the new chairman for Samsung group, Kun-Hee Lee. During this period, Samsung restructured itself to become one of the world's top five electronics companies. Today, Samsung group involve several companies in three different core businesses: electronics, finance, and trade and services. They do their best to be coherently restructured and streamlined, well-designed, globally-focused, and responsive to the need of each market around more than 200 countries (Samsung official website)

6.1.2. Samsung Electronics Corporation

Samsung Electronics Company was established in January 1969 in Suwon, South Korea. They were established to produce electronic and electrical appliances such as; televisions,

[8] The currency of South Korea. 1 USD ≃ 1033 WON, in 2014

calculators, refrigerators, air conditioners and washing machines. In 1974, the company expanded its business to include the home appliances, audio-visual devices and semiconductor industry. By 1982 Samsung had produced over a million colour TVs and 10 million black and white units for sale throughout the world. Then, the company became more comprehensive in electronic products and continued to expand its products to include microwave ovens, air conditioners, personal computers and many others devices. At the end of 1980s, Samsung Electronics launched its first mobile phone in the South Korean market, but the sales were initially small because the phone struggled with poor quality (Samsung official website). In the early 1990s, Samsung Electronics Company challenged itself by changing the strategy of designing, manufacturing, and investing. As a result, in the late-2000s, it achieved rapid success represented in selling a wide variety of electronic products, such as, communication devices and semiconductors.

Samsung electronics is a flagship company of Samsung group. It represents more than 50 % of Samsung group's share. It focuses on four business sectors; home, mobile, office networks and core components[9]. Samsung is considered one of the leading companies in the digital convergence revolution by its innovation (Samsung official website).

As shown in **figure 11**, Samsung has more than 264 products sold through its global network operations. The global network consists of 217 facilities and offices distributed around Europe, China, Southwest Asia, North America, Southeast Asia, Central and South America, Commonwealth of Independent States, the Middle East and Africa. Samsung has 15 regional headquarters, 51 global sales offices, 37 manufacturing sites, 3 distribution centres, 33 global R&D centres in 79 countries, and 6 design centres in United States, United Kingdom, Italy, Japan, China, and India. These centres helped Samsung to win a panoply of design awards (Samsung Sustainability Report 2013). All these facilities helped Samsung to expand its reach even further into electronics, semiconductors, high polymer chemicals, genetic engineering, optical telecommunications, aerospace, and new fields of technology innovation from nanotechnology to advanced network architectures (Samsung history, 2013).

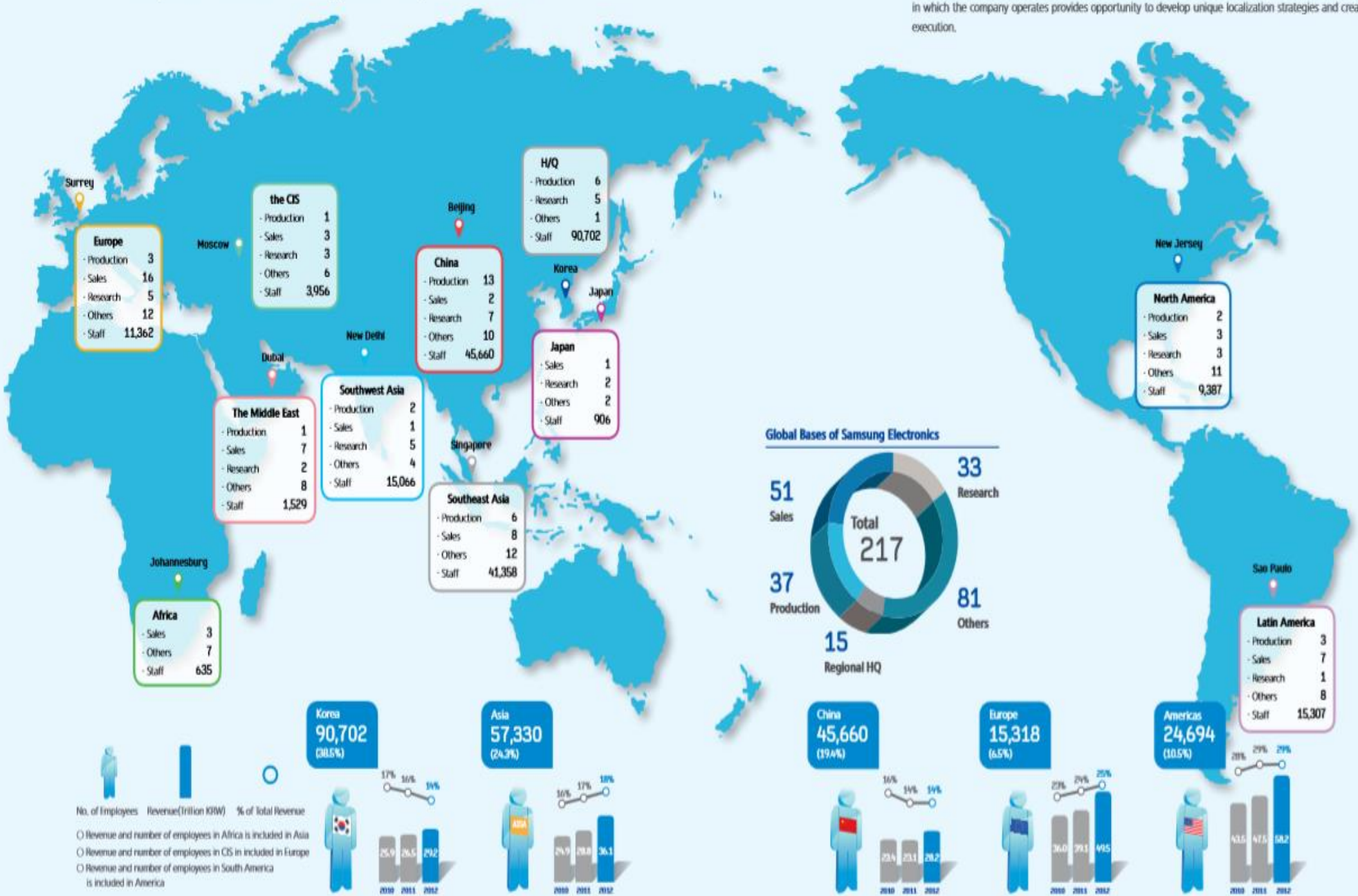
[9] The components which help other companies, for example; Apple Inc., in the manufacturing process rely on Samsung's core components for I-phone manufacturing.

One Company Fueled by Global Diversity

Samsung Electronics began doing business in Korea in 1969. Forty-three years later, Samsung has expanded into 200 countries. Samsung attributes much of its success to its global network of employees, whose creativity and innovation are engines for growth. The diversity of perspective and expertise present at each of Samsung's nine regional headquarters ensures independent strategic development and solutions that can be applied both locally and around the world.

Efficient Resource Allocation and Localization Strategies

Samsung's business operations include 217 locations around the world, including centers of production, sales, design, and research. In order to effectively manage its diverse global portfolio, Samsung Electronics maintains 15 regional headquarters around the world (including its corporate headquarters in Korea). Leadership at Samsung takes care to equip each regional business segment with considerable resources and autonomy. This commitment to each region in which the company operates provides opportunity to develop unique localization strategies and creative global execution.



Global Bases of Samsung Electronics

6.1.3. Organization of business area structure

Figure 12 illustrates the way that Samsung thinks about its businesses in 2013-2014. Samsung's new organizational chart is divided into three key business sectors; Consumer Electronics (CE), IT & Mobile Communications (IM), and Device Solutions (DS). The new arrangement demonstrates the priority of Samsung to upgrade its organizational structure. Samsung's new structure allows each business to make its decisions more quickly and in line with the changes of global market more effectively, besdies it preserves the cooperation between the different sectors (Samsung Electronics Sustainability Report 2013).

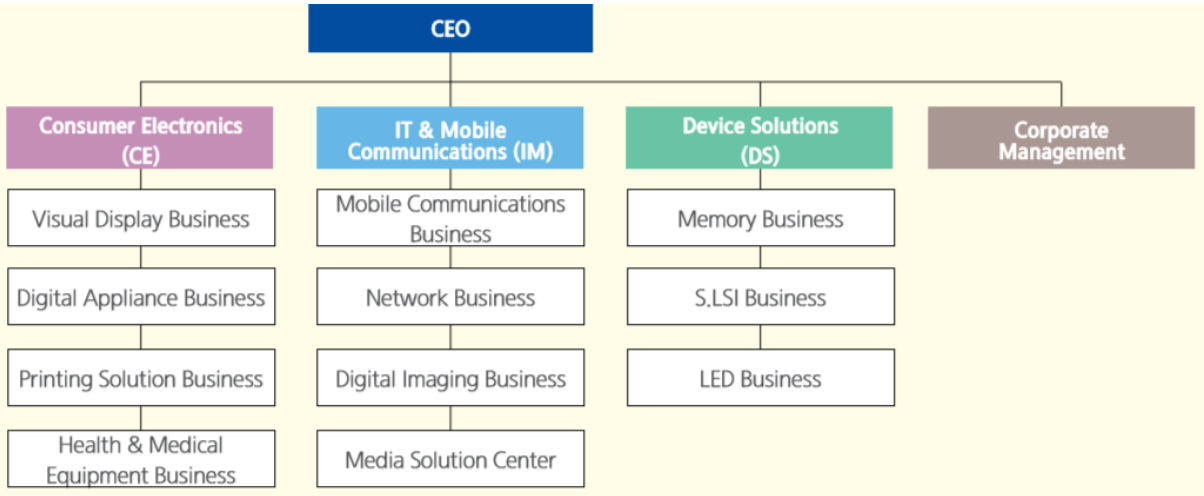


Figure 12: Samsung Organization Chart (*Source:* Samsung Electronics Sustainability Report 2013, pp 16)

6.1.4. Samsung's competitive advantages

The competitive advantage of Samsung Electronics Company stems from the superiority of quality, efficiency, customer responsiveness and superior innovation. The company has an experience of pursuing both, cost advantage as well as product differentiation strategies.

6.1.4.1. Cost leadership

Below, there is a variety of factors that have helped Samsung to achieve this desirable position in cost advantage.

Global R&D: Samsung has a strong commitment to research & development. It has invested at least 9% of sales revenue into R&D activities (Samsung Sustainability Report, 2013). R&D activities allow the company to understand the customer's needs ahead of its competitors and to create innovative products responding to the customer's voice. More, importantly, R&D centres in Samsung focus on the technology which is expected to get the most promising long term results. Furthermore, Samsung has a core design in all its products and builds additional

logic on top of that design to make specialized products. This strategy allows Samsung's production line to be more flexible and achieve the cost-effectiveness for a wide variety of different products (Miranti, 2012).

Raw Materials: Samsung is able to get the best negotiated agreements; however, its raw materials cost 37% less than its competitors and 1/3 of the cost of the final product (Sylvia, n. d.). In addition, the cost of shipping and distribution is low because Samsung's facilities are geographically located at one single site, in contrast to its competitors' facilities which are spread worldwide.

HR Management: Samsung was founded on the statement: "A Company is Its People." This philosophy means that human resources are the key to success. One of Samsung's human resources strategies is to focus on highly-skilled employees from around the world, regardless of nationality. Samsung has untraditional human resource practises based on meritocracy hiring - not on seniority - and evaluation system, reward policies, employees' welfare and benefits to employees' family (Samsung Press Information). These strategies help in creating an atmosphere for innovation.

6.1.4.2. Differentiation Advantage

In differentiating its products, Samsung has four business areas to create a huge number of products covering its customers' need. These area consisting of: *the CE sector*, which encompasses digital TVs, monitors, printers, air conditioners and refrigerators. *The IM sector*, which specialized in mobile phones, ICT systems, and cameras. *The Semiconductor sector*, which encompasses memories and system LSI. *The Display Panels (DP) sector*, which comprises variety products of DP such as TVs, monitors, notebook PCs, and smartphones (Samsung Electronics Sustainability Report 2013). Further, Samsung has the ability to produce 1200 different varieties of electronic products. This can be achieved through aggressively investing into new innovation and learning technology from outside (i.e. US and Japan). In addition, Samsung is creating an unusual internal competition across global production engineering to ensure that it will get superior products in terms of quality and design. This unique strategy keeps Samsung ahead by average 34% price premium over its main competitors (Samsung press information).

6.1.5. Financial summary

Samsung is growing rapidly overseas, and every month a higher proportion of manufacturing, sales and R&D investment take place inside and outside Korea. As shown in figure 13, in 2012, Samsung Electronics achieved its largest leap in year over year sales with a total of 201 trillion WON (an increase of 21.9% over 165 trillion WON recorded in 2011). In term of operating profit, the company earned 29 trillion WON. In net income the company achieved its highest profit ever of 23.2 trillion WON and 44.6 trillion WON in EBITDA.

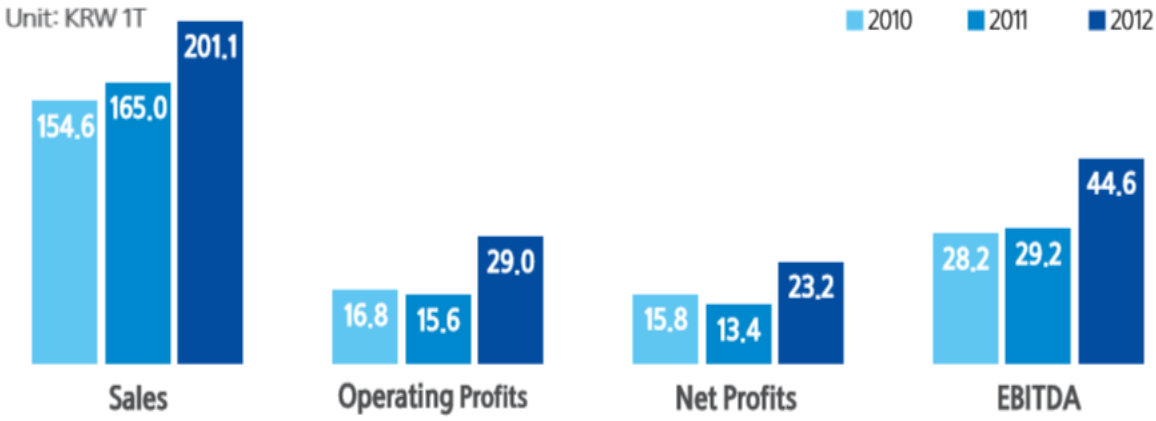


Figure 13: Samsung sales and financial performance (*Source*: Samsung Electronics Financial Highlights, official website)

6.1.6. Samsung global value chain

Figure 14 shows that Samsung depends on the Oracle value chain for hi-tech businesses, which plays a significant role in expanding the company's market share. The value chain of Samsung Electronics Company consists of primary activities and supporting activities. The primary activates are represented in: **product planning and designing,** which is considered as an important activity for Samsung given the rapidly changing in hi-tech market; **Procurement and inbound logistics,** which cover many administrative processes; **manufacturing,** which takes place in major locations for the assembly of components without any reference to outsourcing; **distribution order planning**; **outbound logistics**; **marketing**; **sales and service**. On the other hand, the supporting activities are the **firm's infrastructure** that is related to financial support, corporate governance and new investment support, and **human resource management** which focuses on the employees' skills. The following part will review each of these activities in detail.

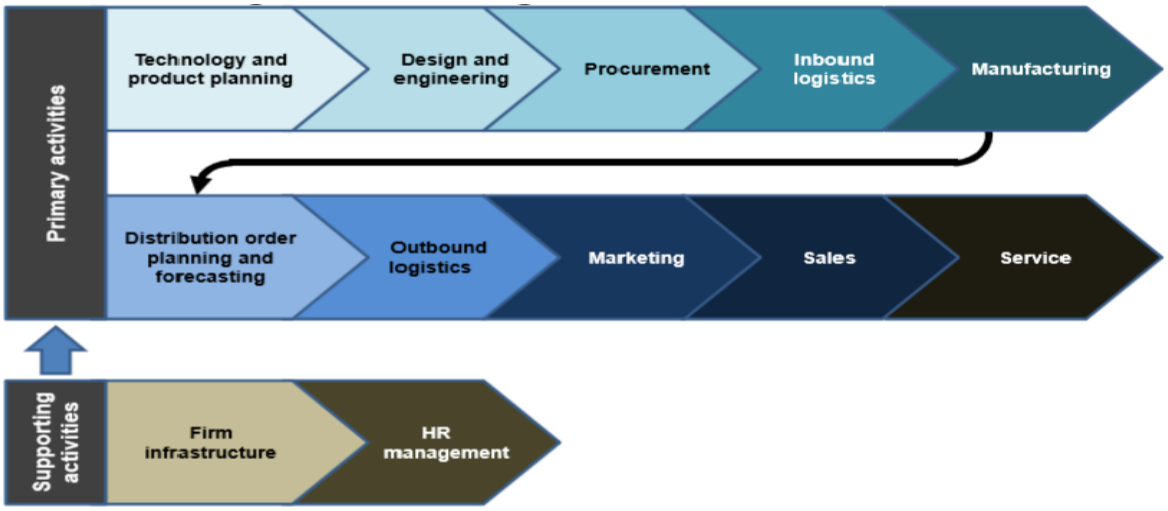


Figure 14: Samsung Electronics Value Chain (*Source:* profitable innovation in High Tech, Oracle KABC analysis)

6.1.6.1. Technology, Design and Engineering

The investment in technology development influences the company's ability to compete and its position in the market. Further, technology and product designing in Samsung are considered as one of the fundamental activities in creating its value. As the electronic sector is growing quickly and needs to keep pace with changes, the total expenditure of Samsung's R&D in 2012 was 9% (Samsung Sustainability Report 2013). Moreover, Samsung has the ability to compete its competitors by new innovations which are being registered to get patents.

6.1.6.2. Procurement

The procurement processes in Samsung are supported by the good relationship with suppliers and partners and well managed functions to maintain the connection between them. Moreover, the IT infrastructure helps Samsung to know more about its partner's capabilities. Samsung's cooperation policy with its suppliers aims to promote a win-win policy which depends on mutual benefit (Samsung official website). The majority of the electronics companies do not produce their components themselves, while most Samsung's activities are intra firm. In this sense, Samsung had a family of accredited suppliers.

6.1.6.3. Logistics

The logistics processes in Samsung are more complex than just described in a basic value chain model. Samsung is very concerned to manage its administrative processes in an efficient way. Furthermore, Samsung has many logistics companies as its subsidiaries to help in managing its logistics processes. The major subsidiaries which accommodate the majority of the logistic

services are named "Samsung Electronics Logitech" and "Samsung Electronics Europe Logistics".

Samsung Electronics Logitech is responsible for handling both inbound and outbound logistics. Its responsibility also involves the payment transaction and dealing with outsourced companies through the global ERP system. Samsung Electronics Logitech provides worldwide ocean/air forwarding logistics (consolidated transport) service for Samsung's products exported from Korea (Samsung Electronics Logitech Company, official website). It provides quick and accurate transport service and cargo tracking information. The following figure shows the import/export logistics processes which are implemented by Samsung Electronics Logitech:

Figure 15: Samsung Electronics Logitech logistics processes (*Source*: Samsung Electronics Logitech Company, official website)

On the other hand, Samsung also has the ability to manage the warehousing and shipping processes. Regarding to shipping, Samsung takes three aspects into its consideration; shipping method, shipping charges, and shipping notification (Samsung official website). The company is keen on finding the minimum shipping charge with the high quality level and accurate time for delivering. According to inventory process, Samsung has the ability to organize its inventory and reduce the cost by collaborating with warehouse's companies[10].

6.1.6.4. Manufacturing

Samsung' manufacturing factories spread out around the world, but most of them are located in Korea, China, Vietnam, and Indonesian (Samsung Press Information). In Samsung, each area is responsible of its own factories and assembly plants. There are some countries which specialize in producing specific product for instance; R&D centre in India produces software and application system, while Samsung Austin focuses on semiconductors production, another factories working on device assemble packaging (batteries and other components) and label.

[10] Samsung has signed a "preferred partner" agreement with Carphone Warehouse Group in 29 January 2014, in order to operate over 60 Samsung stand-alone stores across Europe (Carphone Warehouse official website)

6.1.6.5. Distribution order planning and forecasting

Samsung Electronic Logitech is a specialized company which provides logistics processes for domestic, international, and Business to Business (B2B) cooperation. It also manages a full range of trade support functions for Samsung Electronics Company. It has 3200 domestic partners and 600 partners abroad its networks with a capital of 5 billion WON (Samsung Electronic Logitech official website). By cooperating with Samsung Logitech Company, Samsung is able to create significant value for its products where it has many distribution centres around the world. The most important distribution centres are located in Tianjin and Suzhou as it can handle thousands of electronics products annually.

6.1.6.6. Marketing

Since, Samsung's marketing vision is very much focused on building *Most Preferred and Loved Brand*, it spends a bigger chunk of its annual revenue on marketing and advertising than any other of the world's top-20 companies (Samsung Annual Report 2013). In 2012, Samsung is the world's biggest advertiser with $4.3 billion spending, while its competitor Apple Inc. spent only $1 billion (Kim, 2013).

6.1.6.7. Sales

Samsung has a long-standing presence in many of the world's major markets and has the best geographic coverage in the electronic industry. Samsung has 51 sales offices around world, but the most important offices are located in six big regions; Asia Pacific, CIS Baltics, Europe, Middle East and Africa, North America and Latin America (Samsung Sustainability Report, 2013)**.** Figure 16 shows the total sales which are achieved by Samsung Electronics Company according to the geographic area, and it is clear that the Americas occupy the first place in the last three years by sales percentage of 29%, then followed by Europe and Asia.

	2010	2011	2012
Korea	25,9	26,5	29,2
Americas	43,5	47,5	58,2
Europe	36,0	39,0	49,5
Asia	24,9	28,8	36,1
China	24,3	23,1	28,2

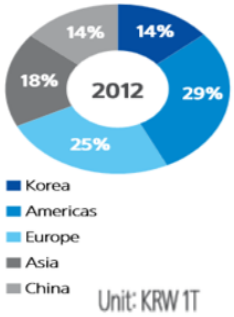


Figure 16: Samsung sales by region (*Source:* Samsung Electronics Sustainability Report 2013, pp 63)

6.1.6.8. Services after sales

In general, Korean companies are characterized by excellence in after-sales service because the reliability of their product is so high and thus the returns are rare, and defects are normally replaced with new items. In 2011, Samsung signed an agreement with a Switzerland supply chain company CEVA Logistics (CEVA official webpage). This company is responsible for organizing the pickup returns such as; phones, flat screens, printers and refrigerators from Samsung's service partners in Switzerland and for bringing them back to the Samsung central laboratory to check if the returned items have an inherent defect or can be repaired. Samsung Electronics Company took various steps to improve its ability to respond to customer inquiries and complaints after sales by following Voice of Customer (VOC) where the issue could be fixed within two working days of receiving the customer's complaint depending on using Global Enterprise Resource Planning (G-ERP), establishing engineer-manned call centre, opening service centres at strategic location, and direct operation of any call centres. All these efforts were made to improve customer satisfaction and maximize synergies with the sales operation.

6.1.7. Global Samsung E-waste Management

6.1.7.1. Samsung e-waste management policy and principals

For nearly ten years, Samsung Electronics Company has taken a leadership role in product recycling through understanding the significance of the e-waste management problem and defining accountability and curves of obligation. It considers e-waste management as one of its international priority issues. Samsung is one of the strong supporters of Individual Producer Responsibility (IPR). The principals of Samsung include protection of people, environment, and developing countries. However, it is committed to progressing ahead and implementing it strongly according to its principles.

Samsung Electronics Company is committed by the international standards and the concept of IPR, which are considered as a critical technique for manufacturers to make more stable and environment-friendly products. This technique reduces dramatically the level of WEEE and avoids the traditional waste disposal which is represented in landfill and incineration (Samsung Electronics official website). To make the IPR mechanism true and possible, Samsung is engaged with NGOs of the highest levels, government discussions, and industry partners which are interested in IPR mechanism. It also follows the European and national authorities to be

sure that the suitable legal framework is in the right place. Samsung encourages the spread of the concept of recovering e-waste by creation several systems to be able to adapt with the huge volume of e-waste and manage them in a friendly way.

6.1.7.2. Samsung e-waste processes

As shown in the figure 17, Samsung makes a significant efforts through its recycling system to reduce and handle its waste. This process starts with collecting all its waste, whether collected from customers or emitted from the production process. Samsung also tries to make the pickup process as easy as possible through establishing a multiplicity of collection programs in many countries as will be explained later. In addition to a mail back programme which allows the consumer to ship any Samsung branded end-of-life product to any recycling partner. Samsung also has its own transportation system to carry all discarded appliances to recycling facilities (Samsung Environmental & Social report, 2007) and the collected products might be warehoused in logistics canters. In the recycling centre, all discarded electronic devices are separated into solid waste and liquid waste to be able to handle each of them separately. The parts and components of solid waste are separated to scrap iron, plastic, non-ferrous metals, and other. Samsung tests all parts and components using an X-ray Fluorescence spectrometer (XRF) to know the presence of hazardous substances (Samsung Techwin official website). Finally, the environmentally-friendly components can be warehoused and reused as valid raw materials. Samsung implements green management program to handle its solid waste by one of the 4R initiative (Reduce, Reuse, Recycle, and Refrain) and the rest of waste which could not be recovered is moved to landfill or incineration.

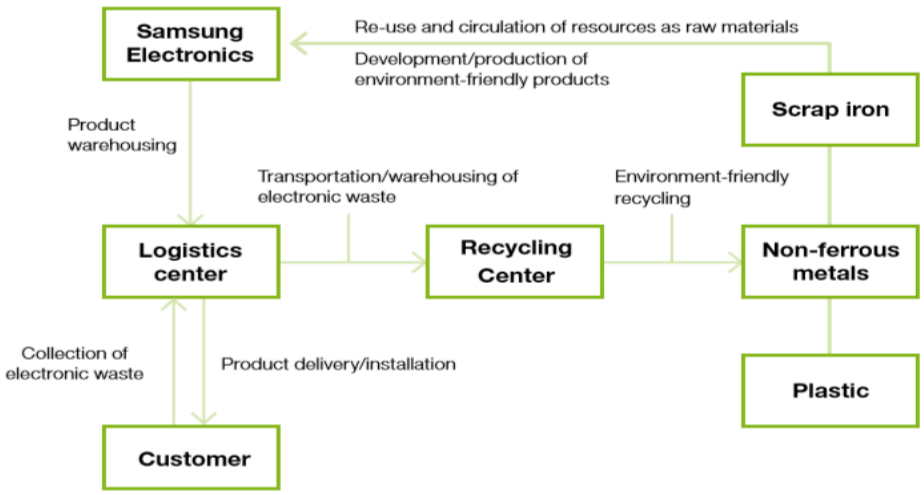


Figure 17: Samsung e-waste collection/recycling system (*source*: Samsung Environmental & Social report, 2007)

6.1.7.3. Samsung recycling activities overseas

Samsung Electronics Company aims to recover all its e-waste generated by its work places or emitted from its customers. To achieve this goal, Samsung thinks in recycling processes as a first step toward environmental protection. Hence, Samsung has established resolutely a nationwide system for collecting and recycling the end-of-life electronic devices which are known as Samsung Recycling Direct (SRD). This program supports the recycling-based society, and it has been of remarkable success in the e-waste recycling system.

- **Samsung Recycling Direct (SRD) program**

SRD is a programme which affords a number of smart methods to help make the world a better, cleaner place. One of the virtues exemplified by this program is commitment to the recycling of electronics product through offering drop off locations to encourage people to recover Samsung-branded and non-Samsung-branded. Samsung Recycling Direct have partnered with strong tack-back and recycling companies who mirror Samsung e-waste philosophy.

Samsung works with leading e-waste recyclers who do not burning, dump, or export the toxic waste to developing countries (Samsung official website). Samsung strictly monitors its recycling partner's performance to be sure that the dispose and recycling process is lawfully performed as improper handling of e-waste can harm the environment. Samsung also follows the partners' performance through conducting extensive research about partners' qualification and capabilities as well as carrying out periodic auditing of their operations and processes according to contractual terms to ensure that Samsung deliver on that promise. The contractual terms oblige each partner not to incinerate, dump or export hazardous waste under any circumstance consistent with the Basel Action Network (Samsung official website). If any partner breaks any term of Samsung agreement, Samsung can immediately end the relationship.

Today, Samsung chooses all its recyclers with very high standards, who have committed to the e-Steward's standard[11] (E-stewards official website) which aims to *eliminate exports of hazardous e-wastes to developing countries*, *halt the dumping of wastes in municipal landfills or incinerators and cease the use of captive prison populations to manage toxic e-wastes*. It also calls for recycler to *strict protection of customer's private data and occupational health safeguards to ensure that workers in recycling plants are not exposed to toxic dusts and fumes* (E-steward Release, 2010). As the e-Steward's principles are consistent with Samsung's policy,

[11] The e-Stewards standard is an environmental, safety and health, and data security management system which has been created especially for recovering electronics.

Samsung is the first electronic producer who joins the e-Steward's standard and this program is considered as a third party validation of the SRD program.

Samsung Recycling Direct is considered as a unique way to manage e-waste because Samsung has connected directly with recycling companies, on the contrary, other electronic companies rely on intermediaries. Also SRD has been committed to transparency for e-Steward's standard and to provide periodic reports about its progress. Additionally, SRD offers four appropriate methods for consumers to back their Samsung-branded and non-Samsung-branded electronics. This method is represented in; *fixed drop-off locations including a mail-back program*, *Samsung-sponsored events*, *Samsung drives with retailers and business partners*, *and non-Samsung-sponsored events hosted by our respected recycling partners* (Samsung e-Waste Management and Activity Report).

SRD was established in 2008 with 175 drop-off locations in the USA, to make people able to back their EoL electronic products around 50 states, and now Samsung runs 700 take back centres around USA. In 2009, over the border in Canada, Samsung have been engaged with Global Electric Electronic Processing (GEEP) and operated 1,476 collection centres to accept Samsung-branded consumer electronics. In India, SRD programme has been initiated in August 2010, to offer drop off facilities for electronic consumer across 21 cities with 235 collecting centres. As well as, in May 2012, Samsung set up a take back program in Australia. On the other hand, the e-waste management in Europe is covered by the WEEE directive where the discarded electronic can be returned for recovering through municipal waste locations or to the retailer if the customer need to purchase a replacement device. Thus, Samsung offers several recycling sites in each EU member regarding to the particular law of each country.

As shown in the following figure, globally, Samsung Electronics is running e-waste take back programs in more than 60 countries. Samsung established all those drop off location in order to take the responsibility for recovering their Eol products, according to the legal requirements of the recycling laws in the place where they exist. Samsung's responsibility involves recycled discarded products in the most effective method to reduce the volume of unrecoverable products and increase the usable materials. Samsung works with governments and industry associations closely to improve the most effective take back techniques to meet its obligations (Samsung Electronics official website).

Figure 18: Samsung tack back network (*source*: Samsung Sustainability Report, 2013)

Samsung also offers specialized system to collect the empty cartridges in what is known as Samsung Take-back and Recycle program (S.T.A.R). This is a free service which is offered by Samsung Electronics Company in 2006 for its printers' customer to return back their discarded cartridges to Samsung. It can help them to prevent substances of cartridges and to ensure that all valuable and reusable materials are recovered. This program represents environmentally conscious for recovering empty cartridges safely. It not only supports disposing of old cartridges by friendly methods, but also encourages people to adopt with environmental responsibility in their daily decisions. As shown in figure 19, the recycling process starts with collection of the empty cartridges, then all the cartridges' parts are sorted and separated into usable components and materials. These components were shredded and/or melted, granulated, and subjected to check through quality test. Afterwards, the recovered materials are reused in a new manufacturing process for a range of products (Samsung Official website).

Since the S.T.A.R program was established in 2006, one million empty cartridges was collected by Samsung from 15 countries across Europe, this is around 1.200.000 kg worth of cartridges. The pledge of Samsung S.T.A.R. program is that all the returned empty toner cartridge are safely recycled, none of returned product is incinerated or sent to dump, all goes through the process of true recycling (Destination Green IT official website). According to Samsung

environmental principles, if some components cannot be recovered, they are handled and disposed of in a method which causes a small effect on the environment.

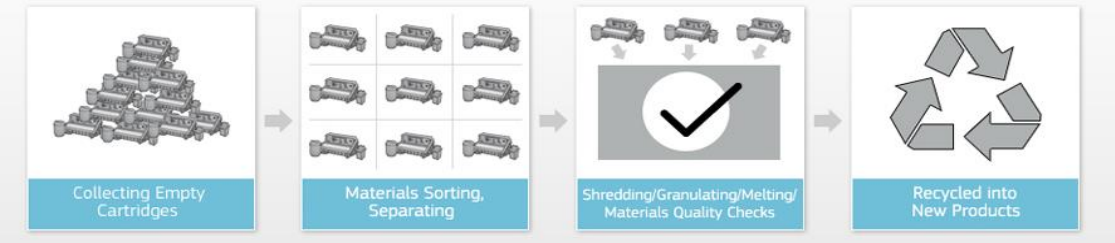


Figure 19: Samsung recycling process for empty cartridges (*Source*: Samsung official website)

Samsung's responsibility extended to involve a refurbishment and reuse project. It supports the principle of repairing the old pieces of equipment provided that this repairing is implemented in a friendly manner by professional people. Moreover, Samsung offers User Manuals for its customer to help them in troubleshooting, as a kind of help in extending the product life cycle. In addition, Samsung encourages the material integration management, which means that the components of discarded products can be used again in the production process of new products or that these recyclable materials are used into packaging.

6.1.7.4. Samsung e-waste recycling performance

Samsung Electronics Company is continually working to increase the amount of recyclable products each year, through establishing global recycling infrastructure, so that it can contribute to minimize damage to the environment. Below are the amounts which Samsung recycled by region from 2010 till 2012 in Asia, Europe, and North America. As shown in the following figure, in 2012, Samsung recycled about 325,000 tons of e-waste. Samsung also plans to expand their recycling activities in all region with a goal of exceeding 30% of e-waste in each region.

Unit: tons

Region	2010	2011	2012
Europe	219,948	245,838	230,492
Asia	60,923	54,233	53,089
North America	22,773	39,347	41,964
Total	303,644	339,418	325,545

Figure 20: Global take-back & recycling quantity (*Source*: Samsung Sustainability Report, 2013)

6.1.8. Samsung e-waste in Egypt

In 2011, Samsung announced plans to establish its first plant in Egypt by investing L.E1.7 billion ($279.3m) and this is considered the first Samsung factory in the Middle East and Africa (Aggour, 2013). Samsung chooses Bani-Sweif in Upper Egypt as one of the best locations for the new factory[12]. This project is considered as a good investment for a country still struggling to find its way for economic flourishing after two years of revolution. Although, Samsung has one of the biggest factories in the Arab region and more than 70 Samsung brand shops in Egypt, they did not have a tangible initiative to solve the e-waste problem in Egypt. Unfortunately, Samsung did not initiate any programs for recycling the end-of-life mobiles or empty cartridges like the global ones (Seddik, George. E-mail interview. 20 April 2014). Samsung has a global Corporate Social Responsibility (CSR) strategy to create a better world, but such strategies are not supported in Egypt since it is regarded as being a developing country.

From the researcher's point of view, Samsung does not strongly care to apply the e-waste approach in Egypt due to the following:

- Samsung negotiates the contracts of recycling e-waste according to the rules and legislation of each country (Samsung official website) and the Egyptian government policies are not strict and need to be clearer and push all companies to abide by sustainability.
- The electronic customer in Egypt does not take the sustainability factor into account during the purchase decision.

Samsung as a leading company should feel obliged to implement the recycling strategy in the place which has a factory, customers, and products for ethical, environmental and economic reasons sooner rather than later. In addition, there are many initiatives concerning the collecting of used devices that are carried out by global companies such as Hewlett-Packard (HP), Motorola and Nokia, in addition the initiative of Mobinil[13] to collect mobile phone batteries.

[12] According to Park the General Manager of Samsung in Egypt, (2013) they choose this site because it is very close to Cairo, it will be easy to access to the Suez Canal, Port Said and Alexandria. Furthermore, the process of exporting the assembled electronic devices to other countries will be very easy.

[13] One of the largest mobile phone operators in Egypt

Samsung press 2012 announced that it intends to set up pilot projects in Egypt and Romania for recycling the discarded devices as a kind of contribution in Mobile Phone Partnership Initiative (MPPI) but till now there are not any take back programs in Egypt for recycling Samsung equipment. Further, all the Samsung electronic devices end up like any other electronic equipment in the Egyptian e-waste recycling network as will be illustrated in the next section.

6.2. The current management system for e-waste in Egypt

As Samsung do not take the same global approach in Egypt to handle its waste, all its discarded products are going into the Egyptian recycling network. Thus, this section will show the current situation of e-waste management in Egypt.

6.2.1. Background

Egypt is one of the most populous countries in the Middle East and Africa, with a population of 80.72 million. It is the 16th most populated country around the world, its Gross Domestic Product (GDP) per capita was US$ 3.25 (World Bank, 2012). Despite the declining of Egypt's economic indicators, the consumer electronics market is larger than some high-economic countries. It is expected that Egypt will be one of the fastest-growing countries which will consume a high percentage of electronics devices over the next few years, and it is predicted that the market size will reach US$5.6bn by 2016 (BMI, 2013). This growth is attributed to the affordability of digital lifestyle products, the availability of bank credit, the emergence of affluent middle class, and the government efforts, such as *'Computer for Every Home*' (BMI, 2011 and MCIT, 2003). Accordingly, Egypt will have a huge quantities of e-waste for the coming decades as many studies mention (El-Nakib, 2012; Allam, 2009; Dahroug, 2010; BCRC Egypt and SWEEP, 2010).

6.2.2. Market status for electronic devices

As there no records of e-waste generation rates are available, it will be useful to know the consumption indicators of electronics devices to give some estimation about the amount of future generated waste. The mobile phone users in Egypt increased from 93.72 million in 2012 to approximately 97.47 million in 2013 and the penetration rate is exceeding 115.92%. Thus, Egypt is the third largest mobile market in Africa after South Africa and Morocco (SWEEP, 2014). The Internet is playing an increasing role in the Egyptian's life thus the Internet subscribers reached 37.14 million in September 2013 (Ahram Online, 2014). The use of other

electronic equipment such as TV sets and satellite has risen dramatically, but not as much as mobile phones and PCs. According to Egypt ICT indicators report in 2013, the investments on ICT sector reached 46.4 billion Egyptian pounds (US $6.6 billion) in 2013, up from 45.88 in 2012. Since 2001 till 2006, the importing of used computers and monitors in Egypt had also grown dramatically, which led to increasing the volume of e-waste. Furthermore, in 2007 importing used computers which are older than five years (it was ten years before) were prevented. Then in 2010, another decree was issued to decrease this period to three years only trying to increase the lifecycle of the used computer as much as possible.

6.2.3. Policy and legislation

The current system of Solid Waste Management (SWM) in Egypt is insufficient and there is no overall integrated environmental policy regarding WEEE. It continues to be a main serious challenge which is facing the Egyptian authorities. There are many environmental protection legislation which are laid down by government of Egypt, but the enforcement of these legislations is still doubtful and their efforts resulted only in a negligible improvement. However, indicators of environmental protection illustrates that Egypt occupies the 60th place in the Environmental Sustainability Index 2012 (EPI, 2012). The legal framework of Egypt involves restrictions on imports of hazardous e-waste and, by virtue, of commitments to the Basel Convention and it also encourages collection, recycling and material recovery practices. As Egypt does not have a specific law for managing solid waste, most of collected waste ends up in local dumps in many areas without any regards for the environment. The absence of serious national programs for managing e-waste and the decreasing price of new technologies, especially mobiles and computers, provide the basis to know that Egypt will sooner or later face the environmental problem issues. This problem is represented in increasing the amount of waste which is going to illegal landfills; accordingly, Egypt has to get ready to adapt with this threat through the means of recycling management.

6.2.4. Stakeholders

Some institutes such as the Ministry of State for Environmental Affairs, the Ministry of Local Development and others have conducted several initiatives and activities to adapt with the concept of e-waste management. Also, the Ministry of Communication and Information Technology and Ministry of Education have launched "*Green ICT*" Initiative. The institutional initiative represented in raising the community awareness, collecting and analyzing data about the types and volumes of waste, and finding appropriate solutions for a sustainable future by

establishing pilot projects (SWEEP, 2010). In addition, the private efforts such as the **Egyptian Electronic Recycling Co.** (EERC), which is considered as the first specialized company which has the ability to recycle the waste in a green way, **Spear Ink** Company which is considered a pioneer company in the field of remanufacturing cartridges (Allam, 2009), and **Recyclobekia** is an e-waste collection company which offers green recycling with a recycling army that protects the earth from pollution. Despite these government institutional initiatives and the efforts of private companies, there are no tangible achievement in the recycling sector in Egypt till now (EEAA, 2010) because they cannot recycle all the volume of generated waste where the quantity of e-waste is growing while the investments in the recycling processes are very limited.

6.2.5. E-waste system overview

The e-waste system in most EU and developed countries is self-organised and the electronic producers of most European Union members are responsible for collecting and recycling their waste without imposing any financial burden on the customers because they follow the principle of IPR. While other electronic manufacturers or importers -in Switzerland for example- follow Advanced Recycled Fee (ARF) policy[14]. The revers logistics for the e-waste problem in Egypt is totally poor. There are not many specialized companies to collect and recycle the electronics waste, but there are several scarp firms which accept any kind of scrap; such as, EoL ships, discarded vehicles, building waste, and old electronic and electrical devices. Then, they can use these waste as a raw material stock for steel mills, smelters and refiners (EEAA, 2010).

Currently, the formal e-waste system almost does not existing, and it is slowly entering the e-waste sector. The collection and recycling processes of e-waste in Egypt are not organised as they are being handled by informal solid waste collectors and recyclers. Therefore, the Egyptian recycling network is considers a private one in relation to all the beneficiaries starting from garbage traders, waste collectors, itinerant buyers, dealers, wholesalers and recycling enterprises. Thus, the e-waste form depends on individual adding value and the primary motivation of those parties is neither the environmental protection nor social awareness but only the financial profit. However, El-Hadary (2011) said that the e-waste recycling business

[14] The policy which imposes fee on consumers when purchasing any equipment to cover the future recycling cost, as a kind of contribution to environment protection.

"*became a national challenge by many organisations, authorities and individuals and even small entrepreneurs to join the industry"*.

The following figure will illustrate the financial and materials flows of Egyptian recycling system for e-waste where the electronic producers shrug off responsibility for their waste after reaching the end of their life.

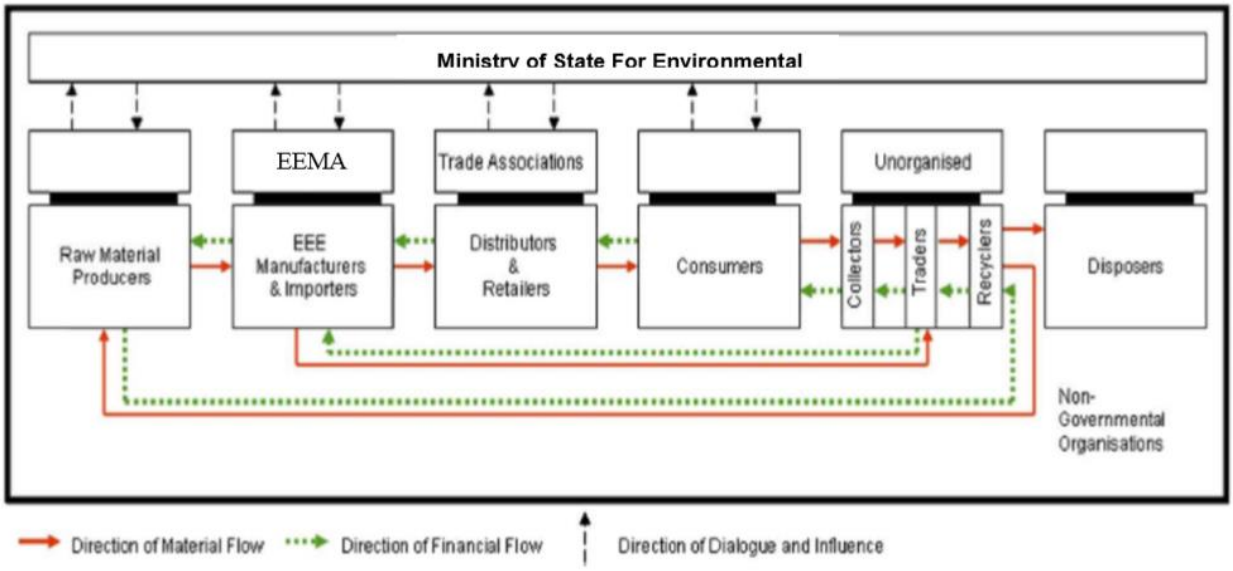


Figure 21: Egyptian e-waste recycling network (Source: El-Nakib, 2012)

The collection process in Egypt is done through an informal sector and irregular channels represented in:

- Garbage pickers or street peddlers who wander the streets using donkey carts or pickup trucks calling for obsolete household devices and buying these electronic devices from households at cheap prices.
- E-waste bought by bidders (often big waste dealers) in tons when some private or public organizations offer their e-waste for sale in a formal bidding as a method to get rid of the outdated equipment (Abdel Aziz, 2014).
- E-waste sorted out by scavengers from formal and informal dumpsites but most of electronic consumer in Egypt do not throw the EoL electronic devices in public dumpsites, as they know that they can gain money from selling them.
- E-waste can also be collected from maintenance and repair workshops.

After that, they accumulate the waste in their garbage villages, and the waste is being sorted and separated into several components and parts. The informal sector is known not only for collecting and transporting the waste, but also for recovering primary materials and trading

with intermediary dealers. Furthermore, they classify the waste into different categories (e.g. computers, printers, copiers, etc.), and sell them independently to the recyclers, second-hand shops or any other beneficiary party.

The recycler can dismantle the collected e-waste and sell the parts by piece (e.g. metal, plastic, chips/boards, and others) to the raw materials companies or burn the integrated circuit boards and wires to extract the copper, without any control procedures. While the second hand shops repair the old electronic devices to resell them, or dismantle the equipment to use the usable materials as spare-parts in other devices; such workshops are widely diffused in Greater Cairo, especially in the lower income areas (Abdel Aziz, 2014). As the informal waste systems are often seen as a sign of failure to modernize, their situation remains unacknowledged by the authorities and government and sometimes even neglected or downright repressed.

According to Egypt State of Environment Report, 2008, the public and private sector can recycle less than 65% of the waste, while the rest of e-waste are either burned or thrown on slum's streets into illegal dumping locations. Accordingly, Samsung devices are among those devices which pass through these informal network because there is not any initiative from Samsung to recycle its products.

6.2.6. Challenges to implement true e-waste management in Egypt

According to EEAA (2010), the e-waste system in Egypt suffers from many difficulties, and it is facing many challenges and constrains represented in the following points:

- The weakness of regulation and rules, as there is no penalties or retribution if the people do not carry out their duties toward their waste.
- Limited control and monitoring levels.
- Insufficient financial resources to establish a coordinated recycling network.
- Lack of obligations imposed on the electronic importers, manufacturers, and owners to force them to manage their obsolete equipment through the "take back" program.
- The recycling system in Egypt is not organized in integrative or economical way.
- Most of the wastes in Egypt are mixed as there is no separation system for the solid waste.
- Many companies cannot release their old computers for recycling because of the privacy concerns and the disclosure issues. They do not want to release the information which was on their computers.
- The random e-waste processes which are followed by the informal sector.

- Lack of efficiency of e-waste collection and sorting which are implemented by scavengers as the waste is accumulated in street or at the waste location.
- Undeveloped and unorganized e-waste transportation methods as the vehicles used to transport wastes are open and could be a source of environmental contamination.
- The sanitary Landfills are not enough, not well designed, not well constructed, and not established according to the international standard and environmental requirements.
- There are not enough skilled human resources in the-waste management area, due to a lack of funds for training.
- There are no accurate sources available to record data regarding the quantities and types of e-waste generated.
- Changing the customer lifestyle, bedsides the lack of community awareness of e-wastes and its possible impacts.
- The negative customer's behaviour regarding their waste.

Chapter 7: Discussion and Analysis

This chapter will discuss some initial model and solution for the Egyptian government to apply a good e-waste management and how they can overcome their obstacles. Moreover, it will involve a model for Samsung to aid in solving the e-waste management based on the relevant information which is investigated in the first part in chapter five. In addition, it will focus on social community and consumer as a part of the cooperative system to handle the e-waste problem. Finally, this chapter draws to a close with a summary of findings and future research.

7.1. Analysis and Recommendation

It is clear in figure 22 that the environmentally sound management of e-waste requires the participation of various stakeholders from the government, public and private sectors, civil society, and consumer as it can give a good opportunity to improve the integrated e-waste management concepts. Moreover, the research will discuss some initial solution and recommendations based on the learnings from Samsung case study and the previous chapters. The recommendations, though mainly aimed at government and policy makers, are also for the other stakeholders namely manufacturers, civil society, and consumers.

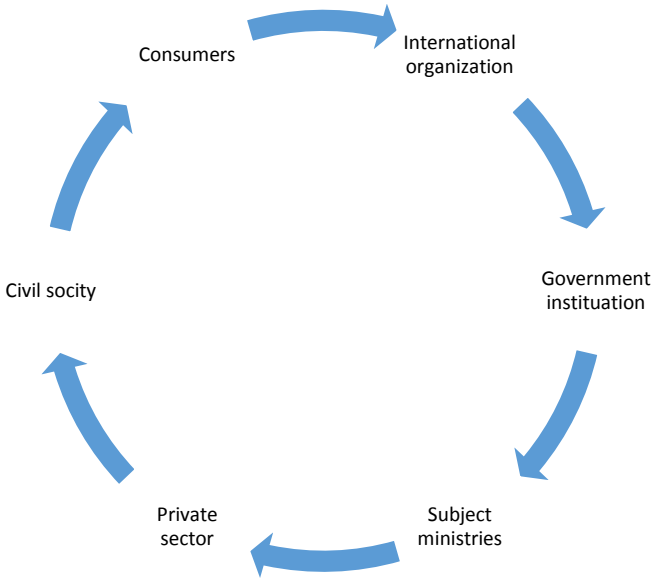


Figure 22: Participation of stakeholders to solve the e-waste problem in Egypt (*source*: author)

7.1.1. Recommendations for Egyptian Government and Policy Maker

Based on the study, the e-waste management sector in Egypt suffers from several problems, and the following section discusses the recommendations to overcome those problems and implementing effective recycling approach:

Obstacle #1: one of the main drivers for the creation of a recycling technology system is the lack of regulation because there is no national consensus on recycling.

Recommendation #1: the existence of a regulatory factor is necessary to manage e-waste efficiently, economically and safely. Further, the Egyptian government should take serious steps to allocate sufficient resources to rigorously enforce existing environmental laws and regulations. An e-waste legal framework, which incorporates responsibilities to importers, manufacturers, and owners, needs to be developed. In addition, the enforcement of law 4/1994[15] for the protection of the environmental and Law 9/2009[16] to force industries to treat and dispose their hazardous waste need to be implemented. Similarity, the WEEE and RoHS Directives of the EU can be used as orientation but adapted to the specific needs in Egypt. On the other hand, Egypt should not be a recipient nor an end destination for old personal computer from abroad. This strategies can be implemented as an effective preventive strategy in E-waste generation in the country. It was suggested that Egypt e-waste policy should be clearly published to sensitize the policy makers and the public alike.

Obstacle #2: in the absence of e-waste regulations and law, the electronic stakeholders do not care about the environment in developing country, especially Egypt.

Recommendation #2: if the regulations and guidelines coming into action, companies will feel that they are obliged to manage their waste by adopting EPR policy. This is an absolutely necessary policy as producers have to be financially, physically or legally responsible for their products and accordingly, they will reduce the volume of toxic substances in their products so they can be easily disassembled for reuse or recycling. Another task would be the setting of guidelines for recycling facilities of electronic companies related to the minimum criteria on employee training regarding worker health and safety, measurement and control of material flow and emissions to land, water and air.

[15] It is Egyptian law which dealing with the Protection of the Environment addressing domestic, municipal and hazardous wastes (SWEEP, 2010).
[16] It is an amendment for law 4/1994 to cover the collection, treatment and disposal processes of hazardous waste only (SWEEP, 2010).

Obstacle #3: lack of institutional and administrative systems to record data as regards to quantities and types of e-waste generated.

Recommendation #3: the government should start to disseminate the culture of waste separation in Egypt by placing several bins for each type of waste so that it can assess the quantity and types of electronic waste clearly. It is recommended that the government should conduct a nationwide study and statistical analysis to know the quantities and types of waste generated, who owns them, and how they are currently collected and treated. The study will also help the recovery rates for the formal and informal sector. At the same time, it would also evaluate the emissions to the environment as a result of the current practices and their effects.

Obstacle #4: ineffective monitoring and control processes which make the companies do what they want freely without fear of any sanctions.

Recommendation #4: it is better to establish a monitoring and evaluation system, in each governorate, for the waste management with specific roles and responsibilities and apply the penalties and retribution on the company which does not carry out their duties toward their waste. Further, the government has responsibility to improve communication between different stakeholders by encouraging them to establish a strategies to dispose e-wastes. These strategies should contain information on waste quantities, composition, and the use of waste treatment methods

Obstacle #5: consumer's lack of awareness and the ignorance about how to handle obsolete electronics. Besides, the lack of efficiency of e-waste collection implemented by scavengers and garbage collectors has a negative result on the development of e-waste approach.

Recommendation #5: the large majority of the population in Egypt still has very low levels of awareness. Moreover, there is a strong need for awareness campaigns by establishing a communication strategy to raise the community participation among all stakeholders. In addition, government has to encourage public media to increase knowledge about hazardous waste. A step towards improving overall environmental awareness could be to introduce a compulsory curriculum in schools and universities on the environmental impacts of waste to become vectors of best practices in relation to the management of WEEE within their homes. On the other hand, the government should find an appropriate mechanism to integrate with the informal sector in the privatization process.

Obstacle #6: lack of possibilities to establish recycling facility centres with standard level, besides the inadequate of sanitary landfills.

Recommendation #6: establishment of infrastructure facilities should be given priority to ensure an effective e-waste management approach. Further, the government should make serious efforts for removing the accumulated waste in streets by closing the open and uncontrolled dumping sites and establish new sanitary landfills. Policy makers can use a mix of economic and noneconomic instruments as initiatives to establish sanitary landfills such as; offer land at concessional rates to facilitate establishing recycling facility. It is recommended that pilot projects in the provinces be established as they could demonstrate a successful business model in the future. Any government agency can become partners in these projects in term of provision of land on concession basis or equity partnership. The government can also contributed to the project cost to make it feasible.

Obstacle #7: lack of experts and human skills in the e-waste area as there is no national trend toward this field.

Recommendation #7: it is better to implement training programs for human resources, and develop the labour's responsibility toward the discarded equipment through organizing an international conferences on e-waste in the presence of labours and workers to exchange the experiences and adapt with new technologies.

Obstacle #8: the e-waste handling processes are very costly due to the number of steps involved. Egypt suffer from the lack of infrastructure and inadequate financial resources to achieve needed services.

Recommendation #8: based on study, there are many strategies which could help to improve recycling technologies and waste management infrastructure; applying a small surcharge on EEE products, manufactured or imported, who do not dispose their waste, applying of the polluter pays principle in addition to the EPR principle. As well as, making an awareness-raising documentary film adapted to the Egyptian context in order to reach a broad audience and convince national and international technical and financial support to can establish a good e-waste infrastructure and improve the standard of WEEE management.

- **Initial proposal for government to establish necessary infrastructure at each stage of the WEEE recycling chain in Egypt**

Table 5: Proposed e-waste management activities in Egypt

Process	Proposal
Collection	-Follow B2B collection circuits for companies, hotels, hospitals, and government agencies. -Organize B2C circuit for households, with door-to-door collection by informal sector, or district waste collection centres.
Transport	-Encourage the operators in this sector (informal sector or dealer) by the acquisition of means of transportation (motorcycles or vans) through loans at subsidised interest rates, payment facilities, etc.
Storage	-Facilitate the acquisition of land to build warehouses for the governmental electronic waste traders who working in this sector to develop the storage conditions (more space, attractive price, specialized zone, etc.) and to avoid open-air storage.
Dismantling	-Integrate with the informal sector through dismantling cooperatives and offer technical and financial support such as; training, professional equipment, personal protective clothing, etc. to improve their environmental quality.
Recovering	-Study the possibility and the cost of having hazardous waste treatment plant or sanitary landfills with stakeholders and subject ministries. -Promote the initiatives for the recycling e-waste by private leader companies or pilot projects.

Source: Laissaoui and Rochat, 2008

7.1.2. Recommendation for Samsung Electronics Company

The private sector can play a key role in developing the e-waste principle by voluntarily phasing out all hazardous chemicals and materials from their products. Additionally, it can take the responsibility for the entire life cycle of these products through effective take back and recycling schemes that are offered free of charge and globally wherever their products are sold. The companies which produce the latest mobile phones and personal computers, with the bright shape, are reaping huge profits. Therefore, they are required to adapt to and not to ignore preventive environmental standards and. Further, Samsung should take the necessary steps to individualise their financial responsibility, and internalize the cost of their own EoL products.

Although the Egyptian producers' responsibility is still a long way off, Samsung should take right procedures toward the reduction and prevention of e-waste problems during the manufacturing process in the future. In the current situation, the recommendation for Samsung as a larger player in electronic sector would be to use as an innovate strategies for leasing and developing organized e-waste management approach.

- **Initial model for e-waste management in Egypt by Samsung**

The model given below, is based on the learnings from the reverse logistics strategy and the best practical solution for e-waste management in chapters Two and Three. Samsung can established a business model for a sustainable e-waste approach based on EPR. The e-waste system will be with the help of the Egyptian Ministry of State for Environment and the Ministry of Communication and Information Technology. Each stage of this model is designed to be profitable for all participants. In addition, it will create thousands of green jobs and supporting logistics and collection networks. The research will define a short description for each specific process.

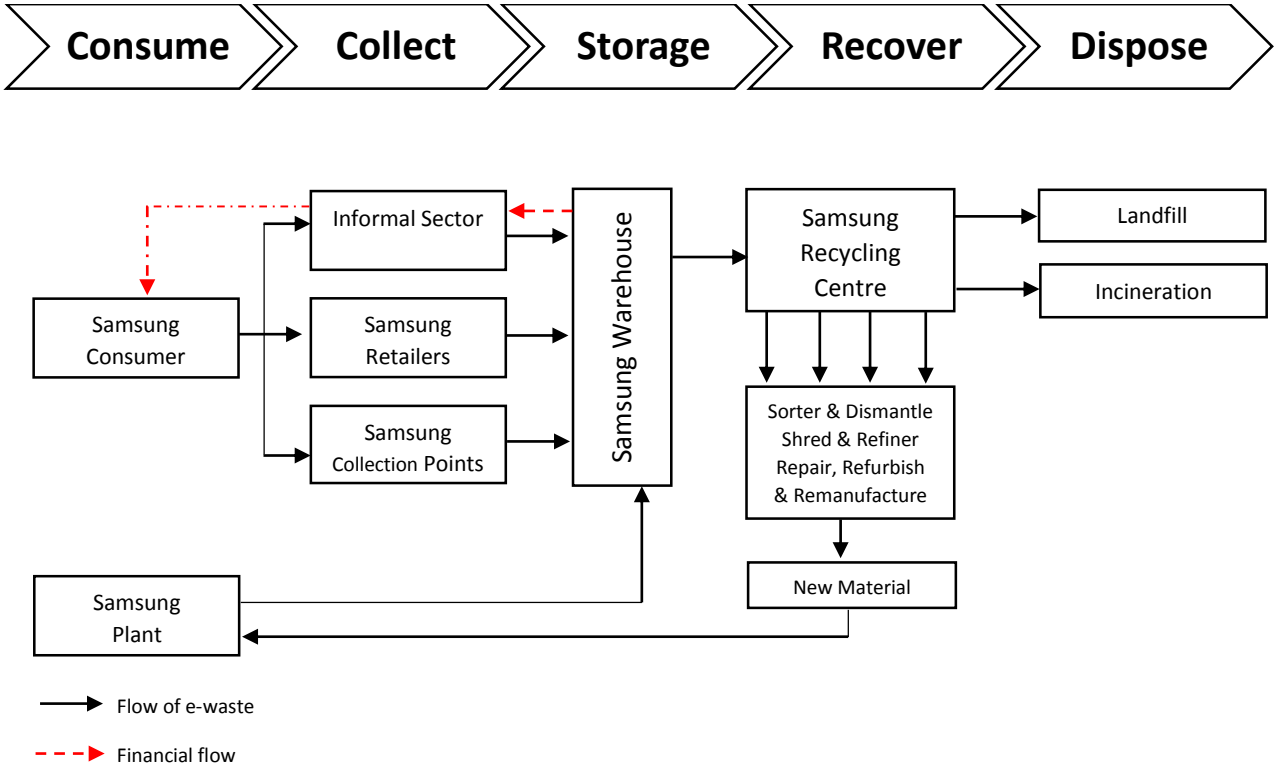


Figure 23: Proposed e-waste network for Samsung in Egypt (*Source*: adapted from Blaser, F. & Schluep, M, 2011)

The **collection** of the obsolete appliances is a crucial part of an e-waste business. On the one hand, the whole treatment chain depends on the supply by this first stage. On the other hand, an efficient and successful collection is probably the stage which is the most challenging to design and plan. Its success depends strongly on the active participation of consumers; in other words, of households, companies and administrations. Moreover, social awareness is generally quite low in Egypt and poses a major challenge for the collection process. Depending on the accessibility and density of the appliances in this sector, various channels have to be established in order to collect the e-waste efficiently. Further, Samsung has to cope with the Egyptian society through three potential alternatives;

- Direct collection of the appliances by establishing Samsung *drop-off location* using geographic coverage. Samsung can distribute these drop-off location in Malls and universities as more educated people ready to return back their discarded products without refund as a part of contribution in solving e-waste problem. Samsung can create a website to give the people information about their collection point locations.
- Indirect collection by commitment with *Samsung retailers* to collect the appliances of major consumers without extra fees. This contract between the retailers and the consumers which assign an exclusive take-back right for the old appliances to the retailers could become very effective. Every retailers should be responsible to provide a box, bin or a demarcated area to deposit e-waste.
- Negotiating directly with the *informal sector* to integrate and cooperate with them (scavengers) by using their experience and collection channels for collecting the household's devices, which require a much higher effort. Finally, Samsung can convert them into trained and legitimately compensated collectors and providing formal labour opportunities.

To make the collection process efficient, Samsung can launch awareness campaigns through publications, advertisements, posters, or by any other means of communication and information booklets accompanying the equipment. These booklets include information regarded to hazardous constituents in electrical and electronic equipment, instructions for handling the equipment after its use, along with the Do's and Don'ts, and affixing the recycling symbol on the products to prevent e-waste from being dropped in garbage bins.

Then the discarded products and their components will be **transported** by truck, either Samsung truck or another transportation contracted company. Transportation by train also can be considered. The destination of transportation process will be to **Samsung warehouse** or to the **Samsung treatment facility** according to the quantity of collected devices. As shown in figure 24, it is a good example of dismantling where products pass through a sorting step. The main goal of the dismantling is to prepare the discarded equipment for the recovering process by: separation of different materials and components, removal of contaminated components, concentration of particularly valuable components by separating them, and generation of employment and inclusion of the informal sector. For reasons of control, efficiency and security, it is essential for Samsung to take account of:

- Organized and logistically reasonable handling
- Careful documentation of the appliance and material stocks and flows,
- Protection of the workers
- Safe handling and storage of the devices and their components (prevent release of hazardous substances)

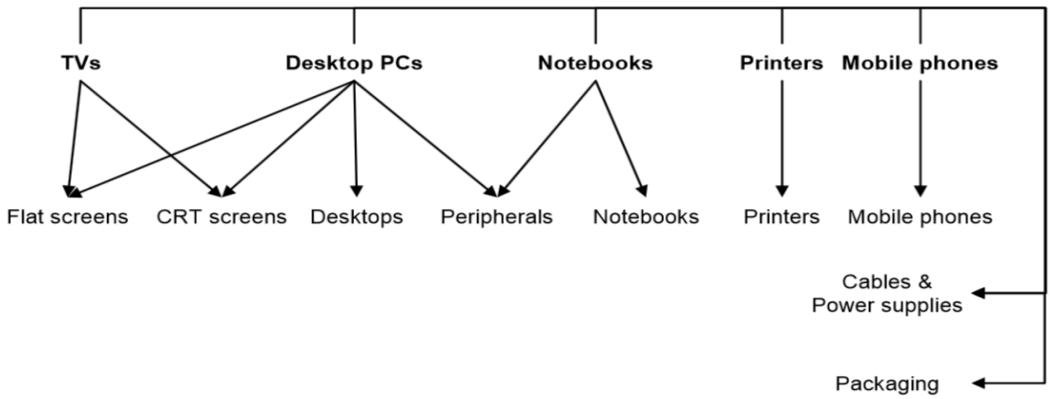


Figure 24: Exemplary sorting tree for the main appliances (*Source*: Blaser, F. & Schluep, 2011)

After the dismantling stage, the separated fractions pass through **recovering processes** which are represented in repair, refurbish, remanufacture and recycle which produces them in the form of new material that can be sold or used by Samsung factory. There are some fractions which are not suitable for recycling and therefore have to be **disposed of** and the most common solution for those fractions is the controlled incineration or sanitary landfills. While there are no developed sanitary landfills in Egypt, Samsung will be responsible for stocking these hazardous materials and shipping them to an appropriate recycling centre abroad.

7.1.3. Recommendation for civil society

Community participation is the best way to achieve the desirable environmental outcomes in a short term through promoting the environmental awareness related to the recycling process. In Egypt, there is a vital need to focus on the long-term awareness campaign and education in the waste field and most awareness efforts should be directed to children, as they are easily responsive. Traditional media[17], community radio, religious leaders, mayors and other opinion leaders should not ignore the e-waste issues. They should cooperate to produce various publications and brochures regarding the significance of managing e-waste and the negative impact of the hazardous waste on health and environment. In addition, the directorates of education, agriculture and health at the Governorates, and the NGO should organized several training and awareness sessions for students and school teachers, farmers, agricultural guides, workers and engineers.

Citizens can voluntarily perform some of the work such as; involvement in encouraging the household to return their e-waste to the drop-off points or to the waste pickup free of charge, and paying for waste collection services by collaborating with waste collection crews. This would reduce the amount of household waste stream.

7.1.4. Recommendation for Consumers

It is known that the majority of people have discarded electronic devices and they want to get rid of them even if they contain hazardous toxic. Nevertheless, there are many simple steps that are required from us as citizens which contribute significantly to the mitigation of pollution sources of e-waste. It is recommended that every citizen should go to the nearest waste collection points, e-waste recycling location or retail stores which have joined to the campaign of recycling e-waste and drop their old equipment. It is really important to encourage the recycling campaigns and to strengthen the partnership with the private sector in order to spread the awareness in the society.

[17] The percentage of environmental issues in reports, interviews, and debates on Arab television channels is under 1 percent, while they reach 10 percent on channels in many European countries (Randa, 2012)

7.2. Conclusion

Looking at e-waste from one perspective is that of an environmental disaster. The other side is a rich source of valuable resources that could be recovered profitably. Moreover, this thesis investigates the particularities of e-waste management in different regions, with different levels of economic development and technological sophistication exploring several approaches which have been adopted in managing e-waste. It focuses mainly on EPR principle which encourages manufacturers to be responsible for the products they generate through their life cycle. The experiences of the developed countries in this field reveals that the legislation has to serve broader societal goals. It means that national laws and regulations are necessary to identify the roles, obligations and responsibilities for the main actors.

The previous chapters prove that the absence of regulation concerning the e-waste and relaxed approach in enforcement, allow the electronic producers to not deal with their wastes in a friendly way causing unwarranted threat to the environment and human health. In this regard, e-waste recycling systems in Arab region could be developed through applying clear regulatory framework as the legislation is considered as a vehicle to achieve tangible success in this field.

Egypt is one of the countries which can be a potential market for recycling e-waste but the process of recovering e-waste is very limited. Egypt is missing most of the required elements to implement e-waste system, it faces a mix of institutional and organizational constraints, in addition to technical problems. For example, there is lack of waste recycling strategies, lack of cost recovery of e-waste service, weak legislation enforcement, limited involvement of private sector and limited public awareness, in addition to the lack of adequate sanitary disposal sites.

Apparently, few companies are interested in the treatment of e-waste in the developing countries. In Egypt, the current efforts are still in the pilot stage with small e-waste throughput and have not yet met the international environmental standards. The thesis investigates the initiatives of Samsung, as a leading company in this sector, to solve the e-waste problem in Egypt, but the company does not follow the global trend in recycling products. Thus, the researcher attempted to suggest an initial model for Samsung to recycle its EoL devices in Egypt depending on the experience of the global Samsung program. This model has been designed to be in line with the situation in Egypt. Besides, the researcher provides some recommendation for the Egyptian government, NGO, and civil society.

The main conclusion of this thesis is that there is no one perfect system, and there is no one right solution for all countries to manage their e-waste. The e-waste system has to be developed and updated according to the countries' situation and culture, with the participation and support of all the stakeholders taking into account that the laws and regulations influence the companies' behaviour towards e-waste management. Nonetheless, it is possible and necessary to learn from the experiences of the developed system and to take what is appropriate.

7.3. Future research

If this study will be used in future research, the authors should focus more on involving more organizations. A more extensive study with several electronics organizations in Egypt could enrich the study with useful results in the field of e-waste management. Other comparative studies between industries as regards reverse logistics would also be interesting for the whole field of reverse logistics processes. The qualitative approach which is used in this thesis can also be used to discuss reverse logistics activities which might be developed for future quantitative approaches of e-waste recycling.

References

Abdel Aziz, Elham (2014) E-waste management in Egypt, Facts and Challenges, MSc. Water quality Management Environmental, *Development General Director*, Hazardous Substances & Waste Consultant.

Aggour, sara (2013) Euromoney: Gross revenues increased by more than 40% over past year, $700m in revenues expected this year: Samsung Egypt General Manager, Daily News, Egypt, available at: http://www.dailynewsegypt.com/

Ahram Online (2014) Mobile phone and Internet subscribers increase in Egypt, vailable at: http://english.ahram.org.eg/

Allam, H. and Inauen, S. (2009) E-Waste Management Practices in the Arab Region. Centre for Environment and Development for the Arab Region (CEDARE), Cairo, Egypt.

Allam, H. (2010): E-waste Management in the Arab Region: Status and Opportunities (PowerPoint). Centre for Environment and Development for the Arab Region and Europe, Cairo, Egypt.

Al-Yousfi, A.B., (2008) "Sound Environmental Management of Solid Waste - The landfill bioreactor" Manama, Kingdom of Bahrain; United Nations Environment Programme UNEP, Regional Office for West Asia (ROWA).

Aydogan E. (2009) "Innovation Policies, Business Creation and Economic Development. A Comparative Approach" Vol. 21, Springer Science, Business Media LLC, New York.

Ballou, R. H. (2004) Business logistics/supply chain management (5th Ed.). Pearson Prentice Hall.

Basel Action Network (BAN) 2011, annual report, Toxic trade news: "178 countries agree to allow the ban on exports of toxic wastes to developing countries to become law." Available at: http://www.ban.org/toxic-trade-news/ access at 23/03/2014

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, BC, http://www.basel.int/.

Bayus, B. (1998) "An Analysis of Product Lifetimes in a Technologically Dynamic Industry" Management Science. Vol. 44, No. 6, pp.763–773.

Beckley, D.K. & Logan, W.B. (1948). *The retail salesperson at work*. Gregg publishing, New York, NY.

Bernon, M., & Cullen, J. (2007). An integrated approach to managing reverse logistics. *International Journal of Logistics Research and Applications*, Vol.10, No.1, pp 41-56.

Blaser, F. & Schluep, M. (2011) Current Situation and Economic Feasibility of e-Waste Recycling in Morocco, EMPA, SWISS e-waste programme.

BMI (2013) Egypt Consumer Electronics Report Q2 2013

Brigden, K., Labunska, I., Santillo, D. & Allsopp, M. (2005) Recycling of electronic wastes in China and India: workplace and environmental contamination. Greenpeace Research Laboratories Technical Note.

Cairncross, F. (1992), "How Europe's Companies Reposition to Recycle", *Four Corners, Harvard Business Review, March – April, pp.34-45*.

Carphone Warehouse, official website http://www.carphonewarehouse.com/

Castell, A., Clift, R., & France, C. (2004) "Extended producer responsibility policy in the European Union: A horse or a camel" Journal of Industrial Ecology, Vol.8 (1/2), pp.4-7

Centre for Environment and development for the Arab Region and Europe http://www.cedare.int/

CEVA Logistics Company, Making business flow http://www.cevalogistics.com/en-NL/Pages/default.aspx

Chick, A. & Micklethwaite, P (2002), Obstacles to UK Architects and Designers Specifying Recycled Products and Materials, Design History Society Conference, Aberystwyth, Wales.

Clegg, A. J., Williams, D. J., & Uzsoy, R. (1995) "Production planning for companies with remanufacturing capability in Proceedings of the 1995 IEEE International Symposium on electronics and the environment, 1995. ISEE. Orlando. Florida, pp. 186-191

Dawe, Richard. L. (1995). Reengineer your returns. *Transportation & Distribution*, Vol.36. No.8, pp. 78.

De Brito, M.P. & Dekker, R. (2002), "Reverse logistics – a framework", *Econometric Institute Report EI 2002-38*. Erasmus University Rotterdam.

De Brito, M.P., & Dekker, R. (2003), "A Framework for Reverse Logistics", *ERIM Report Series Research in Management.* Erasmus Research Institute of Management (ERIM)

Destination Green IT official website http://www.destinationgreenit.com/

Devon Appliance Recycling project (DARP) (2003), DARP Environmental: WEEE Remarket Final Report

Division of Technology, Industry and Economics (DTIE), International Environmental Technology Centre. 2007a. E-waste: Volume 1: Inventory assessment manual (Osaka/ Shiga)

Dowlatshahi, S. (2000), Developing a Theory of Reverse Logistics. *Interfaces* 2000; Vol.30, No.3, pp. 143-155.

Drucker, P.F. (1985) "The Practice of Innovation", Innovation and Entrepreneurship Practice and Principles, Harper & Row, New York.

EEAA (2010). Environmental aspect of the electronic and electrical industries and means for recycling their waste and safe disposal. Egyptian Environmental Affairs Agency, Central Department of Information and Environmental Awareness.

EEB (European Environmental Bureau) (2001). Towards Waste Free Electrical and Electronic Equipment. EEB Argumentation Paper. EEB, Brussels.

El Saadany, A. M. A.; Jaber, M. Y. (2011) A production/remanufacture model with returns' subassemblies managed differently, *International Journal of Production Economics*, Vol. 133, N 1, pp. 119-126.

El-Hadary, H. (2011). For industrial waste treated - recycled - safe disposal. Egyptian National Cleaner Production Centre: Cairo.

Elmas, G. & Erdoğmuş, F. (2011). "The Importance of Reverse Logistics", *international Journal of Business and Management Studies*, Vol.3, No.1, pp. 165-169.

EPI (2012). The 2012 Environmental Performance Index report

Ernst, D. (1997) "From Partial to Systemic Globalization: International Production Networks in the Electronics Industry" BRIE Research Paper, University of California, Berkeley

ESCWA (2007) "Compendium of Environmental Statistics in the ESCWA Region", United Nations Economic and Social Commission for Western Asia.

E-Stewards official website http://www.e-stewards.org/

Ettlie J. E. (2006) Managing innovation: new technology, new products and new services in a global economy, 2nd Ed., Burlington, MA: Elsevier Butterworth-Heinemann, Oxford.

EU, "Directive 2002/95/EC of the European parliament and of the council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment," Official Journal of the European Union, pp. 19–23, 2003.

European Commission. n. d.(a). Waste Electrical and Electronic Equipment. 2002/96/EC

Fleischmann, M., Krikke, H.R., Dekker, R., & Flapper, S.D.P. (2000), "A characterization of logistics networks for product recovery", *The International Journal of Management Science, Omega 28, pp.653-666*.

Fleischmann, M.; Bloemhof-Ruwaard, J. M.; Dekker, R.; van der Laan, E.; van Nunen, J. A. E. E.; and Van Wassenhove, L. 1997, "Quantitative models for reverse logistics: A review," *European Journal of Operational Research*, Vol. 103, No. 1, pp. 1–17.

Fuller, Donlad. A., Allen, Jeff. & Glaser Mark (1996). Materials recycling and reverse channel networks: The public policy challenge. *Journal of Macromarketing*, Vol.16, No.2, p.52-72

Giultinian, J.P. & Nwokoye, N.G. (1975). Developing distribution channels and systems in the emerging recycling industries. *International Journal of Physical Distribution*, Vol.6, No. 1, pp. 28-38.

Giuntini, R. and Andel, T. (1995a), "Advance with reverse logistics," *Transportation and Distribution*, Part 1, Vol. 36, No. 2 (February), pp. 73–77.

Giutini, R. & Gaudette, K. (2003) "Remanufacturing: the next great opportunity for boosting US productivity". Business Horizons. November/December, pp 41-48.

Govindan, K.; Palaniappan, M.; Zhu, Q.; Kannan, D. (2012) "Analysis of third party reverse logistics provider using interpretive structural modelling" *International Journal of Production Economics*, in press, pp. 1-8, 2012.

Gregory J., Magalini F., Kuehr R. & Huisman J., (2009) E-waste take-back system design and policy approaches. Solving the E-Waste Problem (StEP) White Paper, United Nations University, StEP Initiative, Bonn, Germany, 28 January

Guide, V., & van Wassenhove, L., (2002). The Revers Supply Chain. *Harvard Business Review,* Vol.80, No.2, pp. 25-26.

Hair, Jr., J. F., Money, A. H., Samouel, P. & Page, M. (2007). *Research methods for business*. Chichester: John Willey & Sons Ltd.

Hvam, L. (2006) "Mass customisation in the electronics industry: based on modular products and product configuration" International Journal of Mass Customisation, Vol.1, No.4, pp.413–416.

Isabelle M., W. and Gutowski T., G. (2013) EOL Product Remanufacturing and Reuse Economics: Consumer Side and Producer Side. ISSST

Jayaraman, V., Patterson, R.A., Rolland, E. (2003), "The design of reverse distribution networks: Models and solution procedures", *European Journal of Operational Research, Vol.150, p.128-149.*

Jiang, Ping, M. Harney, B.Chen, Y. Song, Q. Chen, T. Chen, G. Lazarus, L. Dubois, M. Korzenski (2012) "Improving the End-of-Life for Electronic Materials via Sustainable Recycling Methods" Advanced Technology Materials Incorporated, Inc. Print.

K. Nakashima. (2006) "Markov analysis of an environmental conscious manufacturing system with stochastic variability". International Journal of Global logistics and Supply Chain Management, Vol. 1, No.1, pp. 17-24.

Kamel M. H. (2010) E-waste, the Basel Convention, and BCRC-Egypt. Presentation at "E-Waste Management Forum: Green Business Opportunities", Marrakech, Morocco

Kamel, Mostafa (2013) "where does Africa stand on the global e-waste issue" director of BCRC-Egypt, e-waste Africa alliance, UNEP

Khordagui, Hosny (2004) "The role of international, regional & the role of international, regional & sub-regional institutions in regional institutions in supporting SD in the Arab region" water & environment team leader, UN-ESCWA. Regional Workshop on National Sustainable Development Strategies and Indicators for Sustainable Development in the Arab Region, Cairo House, Egypt

Kim, K., Ryoo S. & Jung M. (2011). Inter-organizational information systems visibility in buyer–supplier relationships: the case of telecommunication equipment component manufacturing industry. Omega International Journal of Management Science, Vol.39, No.6, pp.667–76.

Kim, Miyoung (2013) "Samsung's marketing splurge doesn't always bring bang-for-buck" available at: http://www.reuters.com/article/2013/11/27/us-samsung-marketing-idUSBRE9AQ18720131127 access at 22/02/2014

King, A. M., Burgess, S. C., Ijomah, W., & McMahon, C. A. (2006). Reducing waste: repair, recondition, remanufacture or recycle? Sustainable Development, Vol.14, No.4, PP. 257-267.

Kokkinaki, A. I., Dekker, R., Lee, R. & Pappis, C. (2001) " Integrating a web-based system with business processes in closed loop supply chains" *Econometric Institute Report* 233, *Erasmus University Rotterdam.*

Krupp, J. A. G. (1993). Structuring bills of material for automotive remanufacturing. *Production & Inventory Management Journal*, Vol.34, No.4, pp. 46.

Laissaoui, S. E. and Rochat, D. (2008) Technical report on the assessment of e-waste management in Morocco. EMPA, CMPP

Lewis, A. 2011. “Europe breaking electronic waste export ban”, BBC News Europe, available at: http://www.bbc.com/news/world-europe-10846395, access at 24/03/2014

LIN C., YAN L. & DAVIS A. (2002). Globalisation, Extended Producer Responsibility and the Problem of Discarded Computers in China: An Exploratory Proposal for Environmental Protection. The Georgetown International Environmental Law Review, Vol.14, No.3, pp. 525-574.

Lindhqvist, T. (2000). Extended Producer Responsibility in Cleaner Production. The International Institute for Industrial Environmental Economics (IIIEE). PhD thesis, Lund, Sweden, Lund University.

Liu, F. (n. d.). Reverse Logistics Matters. Master Thesis. University of Maastricht. Faculty of Business

Lundgren, Karin (2012) “The global impact of e-waste: addressing the challenge” International Labour Office, Programme on Safety and Health at Work and the Environment (SafeWork), Sectoral Activities Department (SECTOR), Geneva: ILO, 2012

Luttropp, C. & Johansson, J. (2010). Improved recycling with life cycle information tagged to the product. Journal of Cleaner Production, Vol.18, No.4, pp.346-354.

Matthews. H.S., McMichael, F.c., Hendrickson, C.T., Hart, D.J., (1997) Disposition and End-of-life options for personal computers. *Carnegie-Mellon University*, Pittsburgh, PA.

Maxianova, Karola. (2008) "Shipping of Electronic Waste: Providing the right incentives through regulation and enforcement." RECIEL, No.17, pp.270-278.

MCIT (2003) Ministry of Communications and Information Technology’s year book

Miranti, dewi (2012) “value chain and competitive advantage of Samsung” available at; http://dewimiran.blogspot.no/2012/11/value-chain-and-competitive-advantage.html access at 01/04/2014

Mollenkopf, Diane (2010) “Reverse Logistics - Effective Returns Management in an Integrated Supply Chain” *Supply chain management review*, *Part 5*,

Murphy, P.R. & Poist, R.F. (1989). Management of logistical retro-movements: an empirical analysis of literature suggestions. *Transportations research forum*. pp. 177-184.

Nakajima, N., & Vanderburg, W. H. (2005). A failing grade for WEEE take-back programs for information technology equipment. Bulletin of Science, Technology & Society, Vol.25, No.6, pp. 507-517.

National Recycling Collation, NRC (1999), Buy Recycled Book, available at: http://www.greenbiz.com/sites/default/files/document/O16F4773.pdf access at 03/03/2014

Ni, H.G.; Zeng, E.Y. (2009) “Law enforcement and global collaboration are the keys to containing e-waste tsunami in China”, in Environmental Science & Technology, Vol. 43, No. 11, pp. 3991–3994.

Niu, X., & Li, Y. (2007). Treatment of waste printed wire boards in electronic waste for safe disposal. Journal of Hazardous Materials, Vol.145, No.3, pp.410-416.

Osibanjo, O. & Nnorom, I.C. (2007) “The challenge of electronic waste (e-waste) management in developing countries”. Waste Management and Research; Vol.26, No.6, pp.489-501.

Pohlen, L. T., & Farris II, M. T. (1992). Reverse logistics in plastic recycling. *International Journal of Physical Distribution & Logistics Management*, Vol.22, No.7, pp.35-47.

Porter R. C. (2002), "The Economics of Waste" Resources for the Future, Washington DC.

Prahinski, C., & Kocabasoglu, C., (2006) Empirical research opportunities in reverse supply chain. *The International Journal of Management Science*, Vol.34, No.6, pp. 519-532.

Profitable Innovation in High Tech Innovate to Compete, Innovate Profitably to Win. Oracle PLM (2003)

Puckett, J. & Smith, T. (2002). Exporting Harm: The High-Tech Trashing of Asia. The Basel Action Network, Silicon Valley Toxics Coalition, Seattle available at: http://www.ban.org/E-waste/technotrashfinalcomp.pdf access at 19/03/2014

Randa, Fouad (2012) Arab Media Forum: A step towards change. Arab Media Forum for Environment and Development (AMFED), UCLA Institute of the Environment and Sustainability.

Ravi, V. & Shankar, R. (2004), "Analysis of interactions among the barriers of reverse logistics", *Technological Forecasting and Social Change*, Vol. 72, pp. 1011-29.

Ritchey, J., Mahmoodi, F., Frascatore, M., & Zander. A. (2001) "Assessing the technical and economic feasibility of remanufacturing: environmental issues". In: Proceedings of the twelfth Annual Conference of the Production and Operations Management Society (POM-2001). Orlando.

Roberts, Mike (2012) "Top 6 Challenges in Electronics Manufacturing". LNC Research, available at: http://blog.lnsresearch.com/blog/bid/146822/Top-6-Challenges-in-Electronics-Manufacturing access at13/03/2014

Rogers, D. S., and Tibben-Lembke, Ronald S. (1999). *Going backwards: Reverse logistics trends and practices*. Reno, NV: Reverse Logistics Executive Council.

Rossem, C., Tojo, N, & Lindhqvist, T. (2006), "Extended Producer Responsibility – an Examination of its Impact on Innovation and Greening Products". The International Institute for Industrial Environmental Economics (IIIEE), Lund University. *Report commissioned by Greenpeace International, Friends of the Earth and European Environmental Bureau (EEB).*

Samsung Annual Report 2013

Samsung Electronics Company, official website

Samsung Electronics Logitech Company, official website

Samsung Environmental & Social report, 2007

Samsung e-Waste Management and Activity Report

Samsung Sustainability Report 2013

Samsung Techwin official website

Schluep, M., Hagelueken, C., Kuehr, R., Magalini, F., Maurer C., Meskers C., Mueller E & Wang, F. (2009). Recycling: From e-waste to resources, Sustainable Innovation and Technology Transfer Industrial Sector Studies (Nairobi and Bonn, UNEP and STeP).

Seitz, Joseph (2014) Regional Study- Global 21, Analysis of Existing E-Waste Practices in MENA countries, The Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb Countries (SWEEP-Net), Tunisia

Singh, G. & Siddique, R. (2012). Effect of waste foundry sand (WFS) as partial replacement of sand on the strength, ultrasonic pulse velocity and permeability of concrete. Construction and Building Materials, Vol.26, No.1, pp. 416-422.

Sinha, D. (2004). The management of electronic waste: a comparative study on India and Switzerland. MSc Thesis. University of St. Gallen.

Song, C. Guan, X. Zhao, Q. & Jia, Q. (2005b) "Planning remanufacturing systems by constrained optimization method with feasibility model". In: the 44th IEEE Conference on decision and Control and the European Control Conference, Seville, Spain, December 12-15, pp 4676-4681

Stock, J.R. (1998). Development and Implementation of Reverse Logistics Programs. *Council of Logistics Management.*

Stoyanov, Svilen (2012). "*A Theoretical Model of Reverse Logistics Network for End-of-Life Vehicles Treatment in Bulgaria",* Master thesis, Aarhus School of Business, University of Aarhus

Strategic Approach to International Chemicals Management (SAICM). 2009. Background information in relation to the emerging policy issue of electronic waste, paper presented at the International Conference on Chemicals Management, Geneva, 11–15 May (SAICM/ICCM.2/INF36).

Sylvia, Namwanje, (n. d.) "Business level strategy Samsung" available at https://www.academia.edu/5220714/Business_level_strategy_SAMSUNG access at 06/03/2014

Terry, S.H. (1869). *The retailer's manual*. Jennings Brothers, Newark, reprinted by B. Earl Puckett Fund for Retail Education, Guinn, New York, NY (1967).

The Regional Solid Waste Exchange of Information and Expertise Network in Mashreq and Maghreb countries Regional Network for Integrated Solid Waste Management http://www.sweep-net.org/

Thierry, M., Salomon, M., Van Nunen, J., Van Wassenhove, L. (1995), "Strategic Issues in Product Recovery Management", *California Management Review, Vol. 37, No.2, p.114-135.*

Tsikoudakis, M. (7. March 2011). Massive recalls put dent in Toyota's reputation. Business Insurance, Vol. 45(Issue: 10), 9-13.

Wang, Feng, J. Huisman, C. Meskers, M. Schluep, A. Stevels, C. Hageluken (2013) "TheBest-of-2 Worlds philosophy: Developing local dismantling and global infrastructure network for sustainable e-waste treatment in emerging economies." Waste Management 32 (2012) pp. 2134-2146, Elsevier.

Webb, L. (1994) "Green purchasing: forging a new link in the supply chain" *American Society of Agricultural Engineer*, Vol.1, No.6, pp. 14-18.

White, J. A. (1994). Reverse logistics moves forward. *Modern Materials Handling*, vol.49, No.1, pp. 29.

World Bank (2014) Arab World Data. http://data.worldbank.org/region/ARB

Zoeteman, B. C., Krikke, H. R., & Venselaar, J. (2010). Handling WEEE waste flows: on the effectiveness of producer responsibility in a globalizing world. International Journal of Advanced Manufacturing Technology, Vol.47 (5-8), pp. 415-436.