

UNIVERSITY OF GHANA, LEGON



**MOBILE PHONE RECYCLING AND REUSE IN THE ACCRA
METROPOLIS: PROSPECTS AND CHALLENGES**

BY

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DECLARATION

I hereby declare that this research is my own work and to the best of my knowledge, it contains no other materials formerly published or written by another person, for the award of any degree or diploma at the University of Ghana or any other institution.

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DEDICATION

This work is dedicated to my late father, Tetteh Buerthey, my mother, Clara Donkor, my dear wife, Anita Quandahor and my children Nhyira Ama Buerthey and Glory Twum-Antwi Buerthey

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ABSTRACT

The rapid advancement in mobile phone technology has also increased consumers appetite for newer versions. This has shortened the average lifespan of mobile phone and induced the need for resources to produce more phones. To ensure the sustainability of the global natural resources, reuse and recycling of mobile phones have been suggested as a potential alternative. The study sought to examine the prospects and challenges associated with mobile phone recycling and reuse in the Accra Metropolis. This is not about an attempt to conserve the limited resources but, more importantly, to manage their end-of-life disposal in an environmentally friendly and healthy condition. Respondents' attitudes toward mobile phone recycling and the perceived risks associated with the recycling process were investigated.

The study employed the mixed method to examine mobile phone recycling, reuse and the potential prospects and challenges in Metropolitan Accra. Respondents were selected from households at Airport Residential, Osu and Nima in order to capture respondents from all the income spectrum (high, middle and low-income communities respectively). The findings revealed that respondents endorse the need for mobile phones reuse and recycling as a way of increasing job opportunities, and reduce the need for raw materials to produce new phones. Further, the respondents also indicated that among the factors they would consider in giving out their mobile phones for recycling will include high recovery price. Concerning the challenges of mobile recycling, respondents alluded to possible pollution if they are not properly managed at its end-of-life. The study recommends the formalisation of the informal mobile phone recycling and the placement of recycling bins at vantage points for people to drop off their used phones for recycling. It further calls for the revision of the regulatory policy governing the management of electronic and electrical waste in Ghana to factor in the role of the informal sector.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADP	Accelerated Development Programme
AMA	Accra Metropolitan Area
AMPS	Advanced Mobile Phone System
ARF	Advanced Recycling Fee
BWA	Broadband Wireless Access
CDMA	Code-Division Multiple Access
EEE	Electrical and electronic equipment
EOL	End of Life
EPA	Environmental Protection Agency
EPR	Extended Producer Responsibility
E-WASTE	Electronic Waste
GAMA	Greater Accra Metropolitan Area
GNPC	Ghana National Development Corporation
GSM	Global System for Mobile Communication
IG	International Gateway
ILO	International Labour Organization
LTE	Long-Term Evolution
MPPI	Mobile Phone Partnership Initiative
NEAP	National Environmental Action Plan
PBTS	Persistent Bio –Accumulative Toxins
PPM	Parts Per Million
PHC	Population and Housing Census
POPs	Persistent Organic Pollutants

RAM	Random Access Memory
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Sciences
SIM	Subscriber Identification Module
TPB	Theory of Planned Behaviour
UMTS	United Mobile Technology System
UNU	United Nation University
USA	United States of America
WEEE	Waste Electronic and Electrical Equipment
WESTEL	Western Tele Systems Liquid Crystal Display
WLL	Wireless Local Loop
3G	Third Generation
4G	Fourth Generation

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Development in information technology has led to a tremendous increase in electrical and electronic waste globally (Weng-Jing et al., 2017). E-waste is a term used to cover all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intention of reuse (UNU, 2014). E-waste production is skewed in favour of developed countries, who as a result of their economic activities and use of technology tend to produce most e-waste (Yin et al., 2014a; Nnorom et al., 2008). In 2016, the e-waste generated globally was 44.7 million metric tonnes, and around 18.2 million metric tonnes were generated from Asia alone (Baldé et al., 2017).

In the same year, the Americas also produced 11.3 million metric tonnes of e-waste while the lowest amount of e-waste was generated in Africa; 2.2 million metric tonnes (Baldé et al., 2017). Unfortunately, Only 20% of the global e-waste generated in 2016 was recycled through appropriate channels with most of the remaining finding their way into landfills and even homes posing severe environmental challenges and hazards (Baldé et al., 2017).

Despite the challenges associated with e-waste, especially in the developing countries where regulations and governing structures are still in its inchoate state and making the management of e-waste very intractable, it has become a significant economic activity for a section of the urban populace (Grant & Oteng-Ababio, 2012). The economic boom associated with e-waste stems from the valuable metals found in electronic waste products which include aluminium, copper to mention a few (Ongondo and Williams, 2011c; Prakash et al., 2010). These minerals are extracted and recycled into finished products (Ongondo and Williams, 2011c). The importance of the e-waste recycling is that it serves as the means

through which valuable metals, which are non-renewable find their way back to the production stream, thus reducing pressure on the natural resources which would have been exploited in large quantities, as well as keeping prices on the low (Schluep et al., 2009). The problem with the sector has been the environmental health risk it poses, especially for those within the informal e-waste recycling sector who employ crude and rudimentary processes in their activities due to inefficient regulations that guides their activity (Amoyaw-Osei et al.,2011).

One electronic product that seems to have gained attention recently is the mobile phone. According to Yin et al., (2014b), there are about 1.13 billion units of mobile phone in use. The production of mobile phones has increased considerably, and as of 2012, there were about 986.25 million users worldwide (Yin et al., 2014b).In 2019 the number of mobile phone users was forecast to reach 4.68 billion¹ The mobile phone users in Sub –Sahara Africa continue to increase rapidly, reaching 367 million subscribers in mid-2015 (Mobile Economy, 2015). In Ghana, mobile subscription at the end of the second quarter of 2017 increased by 1.75% from 35.8 million in the first quarter of 2017 to 36.4 million in the second quarter of the year (NCA, 2017). The increased usage of mobile phone has also increased its share within the e-waste stream.

Meanwhile, the recycling rate for mobile phone waste in Ghana is very low. The low recycling rate has raised questions about how mobile phone waste is managed. According to Wen-Jing Deng (2017:13):

Consumers demand for mobile phones is greater than any other electronic device, and, because such phones have a relatively short life cycle and (perceived) built-in obsolesce, the large number discarded constitutes a significant and growing problem

¹ <https://www.statista.com/statistics/274774/forecast-of-mobile-phone-users-worldwide/>

This is particularly so when earlier studies have indicated that various pollutants, including persistent organic pollutants (POPs) and heavy metals, are released into the environment (the air, water, and soil) when improperly managed. For example, the crude recycling of end-of-life (EoL) mobile phones pose severe health risks to workers and residents of surrounding areas alike (Li et al., 2012). The challenges of the proliferation of mobile phone and its associated waste generation notwithstanding, there have been economic opportunities that have accompanied its end of life (EoL) management (Yla-Mella et al., 2015).

This is because some substances contained in old mobile phones can be reused and recycled, especially for the production of new phones and other electronic equipment. Further, the reuse and recycling of mobile phones are in sync with the Sustainable Development Goals 12 (responsible production and consumption) and more importantly, offer the urban poor (youth) an avenue to make a living through informal recycling of mobile phone.

In the long run, managing mobile phone waste properly will not only reduce the exploitation of finite natural resources but also reduce the amount of waste taken to landfill, which has negative environmental implications eventually. Suffice to state that while the discarded mobile phones contain some inherent valuables which are much sought after for income, they also have a high potential to harm individuals and communities or pollute the environment if not managed appropriately. And as expertly noted by Yla-Mella et al., (2015), an excellent recycling system hinges on consumers awareness of the importance of mobile phone recycling. Put differently, consumers' awareness of mobile phone recycling is critical because it translates into recycling behaviour where people will freely give out their phone for recycling.

1.2 Problem statement

The e-waste industry is among the fastest-growing sectors in the world. Undoubtedly, the management of e-waste continues to be a challenge for city authorities, especially in developing countries. The challenge emanates from factors including inadequate institutional capacity and the absence of an integrated framework that can transform obsolete electronic equipment into usable products (Akhtar et al., 2014).

Recent studies indicate that today, mobile phone waste constitutes a large proportion of e-waste generated and account for about 60 per cent of the total volume of electronic waste (Ozluk, 2012). It brings to the fore issues such as management of mobile phone waste since if it is not well-managed, it can destroy the environment because of the toxic substances it contains. On the flip side, if it is well managed, primarily through recycling, it can regenerate employment opportunities both within the formal and the informal sector (Ongondo & Williams, 2011b). Thus, it is important that attention is paid to mobile phone recycling if we are to manage cellular phone waste in a more sustainable manner.

The management and recycling of mobile phone waste are very much integrated. For instance, consumers awareness of the importance of mobile phone waste, their attitude towards mobile phone recycling, willingness to give off obsolete phones, the collection arrangement and availability of industries engaged in mobile phone recycling are among issues that need to be taken into account in the management and recycling of mobile phone waste. Thus, there is a need for research to pay attention to some of these inter-connected issues mentioned above to offer insight into the prospects and challenges of the overall recycling industry in Ghana.

The overwhelming growth in mobile phone waste globally has generated tremendous research interest. For instance, Geyer and Blass (2010) investigated the management of end-

of-life of mobile phones, especially those that relate to reuse and recycling. The study focused on legislative instruments that guide how these waste mobile phones can be disposed of and also the recycling process of mobile phones in general. It further paid attention to how legislations can foster a cleaner production process to minimise the negative environmental impact, which is usually associated with the recycling of electronic waste materials. Other studies have also looked at consumers' awareness in terms of the importance and challenges associated with the recycling processes (Bouvier & Wagner, 2011; Wagner, 2013).

Additionally, some studies have also looked at end-of-management of mobile phones (Neira et al., 2006; Deng et al., 2017). The Ghanaian economy has also witnessed some studies on the mobile telephony industry. Boadi et al., (2007) provided evidence of the impact of mobile telephony usage on rural businesses, while Overå (2008) examined how Ghanaian traders use their mobile phones in doing business (Cited Afutu-Kotey, 2013). Some other researches have examined youth livelihood and entrepreneurship in the mobile telephony sector (see, for example, Afutu-Kotey, 2013; Afutu-Kotey et al., 2017a; Afutu-Kotey et al., 2017b).

These studies explored young people's experiences of running informal businesses within the mobile telephony sector, including the sale of mobile phones and accessories, repair and providing technical support services, including the sale of airtime and mobile money services. They further focus on how many young entrepreneurs have aspirations which are influencing their desire to stay in the mobile telephone sector.

The livelihood opportunities associated with mobile phone repairs was also explored in this study. Activities like simple technological repair and replacement of broken parts such as screen and microphone units, decoding or unlocking was also interrogated in the study.

Interestingly, most of these studies have failed to look at consumers' attitude and perception towards mobile phone recycling and reuse and the regulatory framework for managing mobile phone waste.

This study adds to the literature on e-waste in Ghana as it focuses on the recycling of used mobile phones. In particular, the study looks at the potential impact of mobile phone recycling in the economy. The relevance of the study stems from the fact that mobile phone has become the most ubiquitous electronic product in the world today (Ongondo and Williams, 2011a) and therefore its proportion of total e-waste constituent is substantial. More importantly, Ghana had seen increased usage of mobile phones since 1992, when the first mobile phone network was introduced (Dwowna, 2014). As at the second quarter of 2017, for example, the subscription rate for mobile phones had increased by 1.75% from 35.8 million in the first quarter of 2017 to 36.4 million in the second quarter of the year (NCA, 2017).

Additionally, the rate of unemployment, underemployment, and indeed, the general lack of opportunities in the formal sector employment, especially among the youth, has proved challenging (Afutu-Kotey, 2013). Nonetheless, these unemployed youth have not been entirely passive; observing their living situation deteriorate, but rather, many have devised alternative ways of livelihood (Wasswa-Matovu, 2012).

In reality, many employed people have created their diversified sources of income-generating activities including recycling of mobile phones. Incidentally, the increasing poverty level in the country which has made it difficult for many to acquire new phones has served an added catalyst. Those who cannot afford new phones because of their economic situation have resorted to used phones. This development raises the need to pay attention to

mobile phone recycling and reuse as a sustainable way of managing the end-of-use and mitigate any potential negative impact of the recycling industry.

Using Metropolitan Accra as the study area, this study explores the prospects and challenges of this emerging industry in the national capital. The study pays special attention to how recycling of mobile phones creates employment opportunities in the formal and informal sector as well as any potential impact on the environment.

Further, the study examines institutional arrangement and legislative frameworks available in the country for managing mobile phone. The choice of Accra for this study is based on several reasons. First, Accra being the administrative and economic hub of Ghana, it has many industries engaged in assembling and recycling of mobile phone waste. Second, there are many informal workers involved in mobile phone repairs and collection of obsolete mobile phones. The third point is that users of mobile phones are ubiquitous, and insights can be obtained from them concerning their awareness of mobile phone recycling and engagement with it.

1.3 Research Questions

Specifically, the study seeks answers to the following questions:

- I. What are the attitudes and perceptions of respondents towards mobile phone recycling and reuse?
- II. Are respondents aware of how mobile phone waste can be managed and regulated?
- III. What are the respondents' perceived prospects and risks associated with mobile phone recycling practices?

1.4 Research Objectives

The main objective of the research is to assess mobile phone recycling and reuse: prospects and challenges in Accra Metropolis. The specific objectives are:

- I. Examine respondents' attitudes and perceptions towards mobile phone recycling and reuse.
- II. To ascertain respondents' awareness of the legislative framework for managing mobile phone waste.
- III. Investigate respondents' perceived prospects and risks associated with the industry.

1.5 Significance of the Study

Prior studies have revealed that used mobile phones and computers contain more valuable substances than any other e-waste material (Robinson, 2009). The increase in the number of mobile phones produced and their shortening life span could also increase the environmental impact if not properly handled. The challenge is not related to the environment alone but also related to the need for precious metals to manufacture new mobile phones (Buchert et al., 2012).

The current study adds to the e-waste literature in Ghana, focusing mainly on mobile phones as a component of e-waste (See Grant and Oteng-Ababio, 2012; Amoyaw-Osei et al., 2011, etc.). The study reinforces the campaign being championed by some service providers such as Vodafone Ghana to reduce improper disposal of electronic waste and promote recycling of unused phones. It contributes to attempts to meet Sustainable Development Goal 11 (sustainable cities and communities) as it seeks to reduce the improper disposal of electrical and electronic waste in general.

1.6 Organisation of the Study

The study is organised into six chapters. The first chapter is the background of the study. This chapter captures the study's introduction, problem statement, research questions, objectives, and also the significance of the research.

Chapter two discusses the literature related to the study. It also presents the theoretical framework underpinning the study, while the third chapter discusses the study area and the methodology of the research. The fourth chapter presents the results and discussions of the first two study objectives. Chapter five also presents the results of the third objective of the study. The last section presents the conclusion, recommendations, and areas for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The introductory remarks in chapter one revealed that mobile phone recycling had become a topical issue for research in both developed and developing countries. This is because a mobile phone like the general e-waste contains both hazardous substances that can be lethal if not handled properly as well as precious metals that can be recovered for reuse. This chapter focuses on some of the empirical studies relevant to this present study. In doing so, it examines the concept of e-waste as it applies to varying contexts and with mobile phone in particular. The value-chain within the mobile phone industry receives attention, so are the global perspective on the prospects and challenges of mobile phone. The behaviour of consumers towards the industry, particularly their perceptions regarding, for example, the convenience of the centres, phone collection and the risk associated with the industry are also discussed. The chapter concludes with a discussion on the theoretical framework that underpins the study.

2.2 Understanding E-waste

E-waste is a term used to cover all items of electrical and electronic equipment (EEE) and its parts that have been discarded by its owner as waste without the intention of reuse (UNU, 2014). It is also known as WEEE (Waste electrical and electronic equipment), electronic waste or electronic scrap in different regions. Electronic waste includes a wide range of products, almost any item from home or business with circuits or electrical components with power or battery supply (UNU, 2014).

According to UNU (2014), WEEE and e-waste can be classified into the following six categories: temperature exchange equipment, screens and monitors, lamps, large

equipment, small equipment, small IT and telecommunication equipment. These comprise mobile phones, GPS, pocket calculators, routers, personal computers, printers, telephones. The majority of e-waste generated in the world can be attributed to rich nations (Panambunan-Ferse & Breiter, 2013). It may be due to their high-income status; hence, they tend to produce more electronic and electrical equipment. Their strong economic background also puts them in the position to afford new electrical and electronic gadgets.

The global quantity of e-waste generation in 2014 was around 41.8 Metric tonnes (UNU, 2014). In 2016, global e-waste generated was 44.7 million metric tonnes, and most of them were generated in Asia; about 18.2 million metric tonnes (Baldé et al., 2017). In the same year, the Americas also produced 11.3 million metric tonnes while the lowest amount of e-waste was generated in Africa; 2.2 million metric tonnes (Baldé et al., 2017). Unfortunately, Only 20 per cent of the global e-waste generated in 2016 was recycled through appropriate channels with most of the remaining finding their way into landfills and homes posing severe environmental challenges and hazard (Baldé et al., 2017). From the available data, it can be deduced that within the space of two years, e-waste generation has increased by 2.9 million metric tonnes.

In most developing countries, the environmental challenges associated with electronic waste arise from the low collection rates, particularly at the household level. This is because the final owner either stores such equipment in drawers for some perceived value or disposes them off through normal household bins, which finally ends up in incineration or land-fills. In an ideal case, optimal resource efficiency and low environmental impacts can be achieved when electronic waste is collected and treated in modern recycling facilities. However, imperfect disposal scenarios continue to generate electronic waste problems nowadays (Grant & Oteng-Ababio, 2012; Amoyaw-Osei et al., 2010).

The e-waste sector in Ghana employs thousands of Ghanaians as well as multi-nationals from other countries, including Nigerians, Togolese, Indians and Chinese (Amoyaw-Osei *et al.*, 2011; Oteng-Ababio, 2012b). Studies by Oteng-Ababio (2012b) and Amankwah (2013) show that the youth in response to increased unemployment are engaged in various recycling activities within the e-waste stream which include the collection of obsolete electronic and electrical equipment, dismantling, refurbishing and other activities within the e-waste chain.

The table below shows the top 10 Used-Electronics imports into Ghana from 2010 to 2014

Table 2.1 Top 10 Used-Electronics imports in Tonnage Volumes, Ghana 2010-2014.

Category	Total Tonnage	% Used
PCs	66,756	8
Refrigerators	66,190	62
Air Conditioners	13,330	99
Radios	5,387	95
Mobile Phones	701	1
LCD Monitors	700	50
LCD TVs	690	15
Irons	416	25
Stereos	371	88
Kettles	113	19

Source: Grant and Oteng-Ababio, 2019

One essential characteristic of e-waste scenario in Ghana is the fact that the rate at which electronic gadgets became obsolete is not known (Oteng-Ababio, 2012b). This is as a result of inappropriate data management practices and the fact that a number of them come in already obsolete (Oteng-Ababio, 2012b).

2.2.1 Exemplify e-waste: the case of mobile phone

As one of the smallest and most used devices, mobile phones are an essential contributor to electronic waste (Ongondo & Williams, 2011b). Over the years the number produced has increased, and its management in terms of collection and disposal has become problematic. Wilhelm et al. (2011) and Geyer & Blass (2010) also predicted that the number of mobile phones being retired every year would continue to grow, yet, only a small amount of these phones are collected.

In India, the amount of electronic waste generated directly by mobile phones is expected to increase by 18 times by 2020 (Perkins et al., 2014), and in China, approximately 70 million mobile phones enter the e-waste stream every year (Wang et al., 2011). In the United Kingdom, it is estimated that higher education students alone have 3.7 million phones stockpiled (Ongondo & Williams, 2011a) while in the United States of America there are an estimated 26.1 million mobile phones stored (Ongondo & Williams, 2011a). In the case of Ghana, there is no data on the number of mobile phones being stockpiled. Mobile phones are now being designed to be more environmentally friendly; for instance, Huawei has five mobile phones certified at platinum UL110 certification (Huawei, 2015).

This certification was developed by UL, a multinational company, to measure the sustainability of mobile phones (Coffey, 2017). Although some progress has been made on making mobile phones more environmentally friendly, the issue of managing mobile phone wastes once they reach their end-of-life remains problematic. The problem with mobile phones is that they are being created in large numbers, which is worsened by their rapid rate of succession, as new brands are released (Wilhelm et al., 2011). This short life cycle of mobile phone along with low recycling rates means the issue of mobile phone waste will continue to rise (Perkins et al., 2014).

Mobile phones that are collected for reuse often end up going to third world countries (Panambunan-Ferse & Breiter, 2013), however, the importation of mobile phones for reuse can be problematic because, in developing countries, the import and recycling of e-waste are often not regulated (Heacock et al., 2015).

On the other hand, if it is well managed, primarily through recycling, it can generate employment opportunities in both the formal and the informal sector (Ongondo & Williams, 2011c; Yla-Mella et al., 2015).

2.3 Tracing the value-chain of used mobile phone industry in Ghana

In Ghana, there are numerous sites known for the informal recycling or recovery of EoL mobile phone materials. There are major centres in various cities. In Accra it is Agbogbloshie. Oteng-Ababio (2011) studied informal practices of e-waste management at Agbogbloshie and found that the economy of electronic waste in Agbogbloshie is highly stratified and includes four main activities which are: collection, recycling, repair and refurbishment, and trading of metals. It must be emphasised that the informal recycling of EoL mobile phones in Ghana is not all that different from what Oteng-Ababio (2011) enumerated in his study on e-waste management activities which were the collection, recycling, repair and refurbishment.

The collection of EoL mobile phone in the informal sector is done by informal collectors also known as scavengers (Prakash *et al.*, 2010) who do door-to-door collection and buy obsolete mobile phones from private, corporate and institutional consumers at relatively low prices and bring them to the scrap yard. According to Medina (2008), an estimated one per cent of the world's population is supported through the collection and sale of recyclable waste where most of these happen in the informal sector.

Initially, collectors in Ghana paid nothing for these EoL mobile phones. Collectors sometimes travel long distances and sift garbage containers, visit landfills and other garbage dumps for EoL mobile phones. Some of these collectors are sponsored by intermediaries and even recycling companies who buy obsolete mobile phones. But this is based on the long-established relationship between the collectors and recycling companies. It becomes necessary when the demand for the EoL is high. A socio-economic survey conducted by Prakash et al., (2010) found that the monthly incomes of e-waste collectors range from US\$70 to 140 while refurbishers / repairers earned between US\$ 190 to 250, and recyclers between US\$ 175 to 285.

Refurbishers/repairers are those that provide the service of getting the non-functioning mobile phone work again. Refurbishers transform old/non-functioning mobile phones by replacing defective components. They engage in cleaning and repairing activities to make the refurbished phone more attractive and affordable to most Ghanaians. The informal recycling of the electronic waste in Ghana is carried out by scavengers and dismantlers (Oteng-Ababio, 2011)

The leading mobile phone informal recycling activity in Ghana is the manual dismantling of the mobile phone and the recovery of the precious metals like gold, silver and most especially the motherboard of the phone. Some of the plastics from the EoL mobile after the dismantling process are sold to plastic companies in Tema and North Industrial area while others are dumped in landfills.

The recovered motherboards and the other precious metals that are recovered are also primarily sold to recycling companies at North Industrial area, Tema and other private companies for export. Some of them are also sold to intermediaries, who in turn sell them to the merchants/companies they know.

2.4 Recycling and Reuse opportunities in mobile phone

Recycling and reuse of mobile phone are not independent of each other (Geyer and Blass, 2010) because refurbishers handle the vast majority of collected end-of-use handsets; they are also the largest source of mobile phone for recycling (Neira et al., 2006). Recycling means the processing of waste, i.e. unwanted or useless materials into new products to prevent potentially useful products going waste, reduce the consumption of virgin raw materials, reduce energy usage, reduce air pollution, and water pollution by reducing the need for waste disposal (Geyer and Blass, 2010). For this study recycling of mobile phone will be conceptualised as breaking down the mobile phone into its composite parts in making new products. Currently, there is no consistent terminology for product reuse (Geyer & Blass, 2010). The different terms that are often being used usually reflect some level of reprocessing (Geyer & Blass, 2010).

Reuse is the generic term for product recovery, but most of the time points towards no or little recovery (Geyer & Blass, 2010). Reuse will also be conceptualised as passing a mobile phone onto a third party for use, but not recycling. It can include giving or selling the mobile phone to friends, family, charity, or even being used as a trade-in for a new mobile phone.

Recycling programs for mobile phone started in the '90s in Europe (Tanskanen, 2012). Like all electronic products, mobile phones consist of a multitude of diverse constituents, which in turn are made of many different materials and substances (Geyer and Blass, 2010). To ascertain the recycling potentials of mobile phones, it is expedient to know its material composition. Current models of mobile phones consist of roughly 25% metals, 30–50% plastics with the remainder being glass, ceramics, and epoxy (Wright 1999; Oiva et al. 2000; Lindholm, 2003; Huisman, 2004). Majority of the metal mass of mobile phone is made up of copper, steel, and aluminium (Geyer & Blass, 2010).

According to Geyer and Blass (2010), mobile phone recycling is mostly about the recovery of metals and specifically copper, silver, gold, and platinum group metals. To meet the 65% mass recycling target, additional disassembly and separation steps and most likely even redesign of the mobile phone will be a step in the right direction (Burkhard, 2002)

To eliminate the possibility of any harm, Maragkos et al., (2013) asserted that the waste from mobile phones should be recycled and need to be treated under an environmentally sound management scheme. Velmurugan (2016) advised that manufacturers of mobile phone create an incentive by redesigning mobile phones to be more recyclable, less toxic, and easy to be refurbished. Velmurugan (2016) also opined that an environmentally responsible mechanism should be developed for the recycling of EoL mobile phones.

Hu et al., (2012) found that some components of a mobile phone can be harvested for use in some application in the future, and the effects of hazardous, electronic waste can be reduced. Per the Basel Convention and the guidance document of the Mobile Phone Partnership Initiative (MPPI 2006: 64),

“Re-use, directly or via repair or refurbishment is usually the preferable option over recycling and disposal from an environmental perspective. Reuse can extend product life and means less environmentally damaging extraction, less energy consumption, and less waste. Re-use of a second-hand phone can also often mean a lower price for it, thus increasing accessibility for more people who might not otherwise be able to afford the product.”

Vodafone (2013) encouraged customers to return their unwanted mobile phones and accessories for reuse (if possible) and recycling. They informed people about their recycling programs through posters, brochures, collection points in the store and prepaid envelopes with new phones (Velmurugan, 2016). Vodafone also offers some incentives for its customers to keep their phones for a more extended period, for example, offering SIM-only

pricing plans with a lower monthly subscription rate for customers who continue to use their existing phone instead of updating. (Velmurugan, 2016).

Vodafone Ghana, in partnership with Recell Limited, launched a mobile phone recycling campaign to reduce improper disposal of electronic waste and promote recycling of used phones in 2016 (Citifmonline,2016)². The recycling campaign also sought to minimise mineral extraction and energy consumption in the manufacture of new phones.

The project aimed to give mobile phone users the opportunity to properly dispose of their mobile phones and batteries conveniently at Vodafone shops across the country (Citifmonline, 2016). In achieving this, Vodafone Ghana placed collection bins in all their shops to give Ghanaians and customers a convenient way to dispose of their old phones and batteries. Those who also dispose a used phone and old phone received an encouraging incentive from Vodafone Ghana (Citifmonline, 2016).

2.5 Prospects and challenges of the mobile phone recycling industry

Mobile phone recycling is associated with some prospects and challenges. Mobile phone recycling is a two-sided element concerning e-waste in Ghana; the threat that it poses to human health as well as the environment, and the socio-economic dimension that can be harnessed properly and extensively to aid in the socio-economic development of Ghana. One challenge that policymakers in Ghana and Africa as a whole face is how to come out with a policy that brings the best out of mobile phone recycling and also reducing its impacts on humans and the environment. Some of the prospects and challenges are discussed below.

2.5.1 Interrogating Prospects of mobile phone recycling

An important area of discussion in the context of mobile phone recycling is the economic viability of recycling (Sarath et al., 2015). Navazo et al. (2014) estimated that the energy

² <http://citifmonline.com/2016/03/vodafone-launches-mobile-phone-recycling-campaign/>

needed to recover metals of 1 ton of waste from mobile phones is less than or equal to half of what is required to extract same materials from the mines (Cited Sarath et al., 2015). They also indicated that, although there is a significant saving of energy and costs in the recovery of metals from used phones, only a small amount of mobile phones reach the recycling facilities (Cited Sarath et al., 2015). If more mobile phones are recycled, colossal savings in terms of energy and resources can be achieved (Sarath et al., 2015)

In the opinion of Velmurugan (2016), Nickel-cadmium batteries, nickel-metal hydride and lithium/polymer ion batteries have metals that can be recovered and reused in products such as power tools, pans and new batteries. For instance, the recovery of silver and gold can be used to make jewellery (Velmurugan, 2016). The metals that are extracted through this process can be put back in productive use.

Some studies indicate that about 80% of the materials that are used in the manufacture of mobile phones can be recycled effectively (Moltó et al., 2011). Technically, mobile Phone contains 13 parts per million (ppm) copper, 3500 ppm of silver, and 340 ppm of gold and, 130 ppm of palladium which when recycled can reduce pressure on the limited natural resources (Umicore, 2011). It also ensures the sustainability of the limited natural resources because they will not be mined regularly for the production of mobile phone.

Again, if a mobile phone is well managed, primarily through recycling, it can generate employment opportunities both within the formal and the informal sector (Ongondo & Williams, 2011a; Neira et al., 2006).

Although informal recycling of e-waste and for that matter mobile phone recycling in Ghana have adverse effects on human health and the environment, yet it is also a source of livelihood for many of the urban poor, especially the migrant youth from the three northern regions. Most of them have very little or no education at all and they migrate to the cities in

search of greener pastures (Oteng-Ababio, 2012b). Again, mobile phone recycling will also help sustain our environment from land pollution and help Ghana achieve Sustainable Development goal 11 (Sustainable cities and communities), because waste mobile phones will not be disposed onto the environment. Mobile phone recycling will also generate revenue to the Ghana government since industries that are engaged in some form of disassembly and recycling of mobile phone will pay tax to the government. The workers employed by these recycling companies will also pay tax on their income. Recycling of mobile phones will also lead to the transfer of technology to the younger generation.

2.5.2 Interrogating challenges associated with mobile phone recycling

The recycling processes of mobile phones can also represent a risk to the environment if they are not treated properly at the end of their life cycle. A mobile phone can contain more than 40 elements (Protomastro, 2009) and has an average of 20 metallic elements, 12 of which are considered potentially hazardous, constituting 35-40 per cent of the total weight of each device (Wu et al., 2008)

Earlier researches have revealed that some of the substances can leak into the environment or cause health and safety risks in the treatment phase. Tanskanen (2012) indicated that some of the challenges of mobile phone recycling is the failure of the recycling system since each stage has an impact on the other. The biggest challenge of recycling and, for that matter, the recycling of mobile phones is the lack of consumer awareness about the possibilities of collection and recycling, therefore, leads to low collection demands (Tanskanen, 2012).

Another challenge is the pre-treatment phase, taken care of by recycling companies which separate the different materials in a product (Tanskanen, 2012). Each stage of the recycling process has a lower lateral flow of elimination of the fraction that cannot be processed

anymore, such as wet cardboard packaging (Tanskanen, 2012). The chemicals in mobile phones such as arsenic, lithium, cadmium, copper, lead, mercury and zinc are considered highly toxic because these substances cause severe environmental pollution (Velmurugan, 2016). Bereketli et al. (2009). Lincoln et al. (2007) also stated that mobile phones contain a large number of dangerous substances, including antimony, arsenic, beryllium, cadmium, copper, lead, nickel, zinc and these persistent bio accumulative toxins (PBTS) have been associated with cancer and other types of reproductive cancer, neurological and developmental disorders.

If these hazardous materials found in the mobile phone are not adequately handled, it can be very disastrous. It presupposes that if the correct recycling procedures are not followed, diseases will be rampant, and it will have severe consequences for the health of the people. Carbon dioxide emissions and global warming can also be attributed to the energy and raw materials used to produce millions of new mobile phones (Velmurugan, 2016).

Until the 1990s, mobile phone batteries were mostly nickel-cadmium (Ni-Cd). Because cadmium is a persistent and bio accumulative toxin (PBT), these batteries were banned in the European Union (Velmurugan, 2016). Mobile phone producers opted for lithium-ion or nickel-metal hydride battery even though these batteries contain cobalt, zinc, and copper, and may also pose some risk for human life and can explode through the informal recycling of mobile phone (Velmurugan, 2016).

A lithium-ion battery contains about 3.5g of cobalt (Hagelüken and Meskers, 2008) which represents a high demand for raw materials and a real environmental concern when multiplied by more than 7.1 billion mobile phones subscribers globally (ITU Report, 2015). In landfills, the metals from mobile phone batteries have the potential to leach slowly into the soil, groundwater, surface water and even the geological structure of the land (Silveira

et al., 2010). Robinson (2009) also indicated that improper disposal and recycling of waste mobile phone causes significant health effects and land degradation in developing countries.

In situations where recycling infrastructure is available, understanding a household's willingness to participate in a recycling program is still crucial (Saphores et al.; 2006). It presupposes that having a facility is not enough to propel people to recycle their mobile phone, but their desire to participate in a recycling program is the most important thing. Another challenge with recycled phones is that there has been a reduction in handset mass of 66% and gold content of 60% over the period from 1992 to 2004 and the gold content might reduce further (Geyer and Blass, 2010).

2.6 Consumer behaviour towards e-waste recycling

With the increase in e-waste, recycling is an effective way to solve an environmental problem. Scholars have conducted many studies on e-waste recycling behaviour (Wang et al., 2016). The results focused on recycling habits, recycling attitudes, infrastructure construction, income, education levels, and other factors (Wang et al., 2016). Tonglet et al. (2004) argue that some of the factors influencing e-waste recycling behaviour include: recycling attitude, previous recycling experience, and a concern for the community and the consequences of recycling. Nixon and Saphores (2007) studied the factors that influence willingness to pay an advanced recycling fee (ARF) for electronics. The results showed that age, income, trust in the government and enterprises, and the distance from the recycling system, level of educational attainment, and environmental attitudes exert significant effects on the behaviour of consumers.

2.6.1 The case of consumer attitude to mobile phone recycling

The recycling of mobile phones will be very effective if the consumer has prior knowledge about recycling. Some researchers have paid attention to the attitude of the consumer

towards the recycling of their old mobile phone due to the low rate of mobile recycling between developing and developed countries (Sarath et al., 2015). Nnorom et al., (2009b) examined the response of the Nigerian population to mobile phone recycling. For their study, a mixture of people, such as urban and rural, educated and uneducated, and those with high and low incomes, were selected, to avoid bias. Their research confirmed the fact that approximately 80% of Nigerians were willing to pay for green phones with less toxic components. In their findings, they also observed that the majority of the population was willing to recycle their old mobile phone (Cited Sarath et al., 2015). They concluded that the population is aware of the environmental deterioration that is taking place and are willing to participate in any recycling program (Cited Sarath et al., 2015).

Ongondo and Williams (2011a) also surveyed the behaviour of university students towards the use and elimination of mobile phones. In their research, they found out that about 3.7 million mobile phones are stored by UK students in higher education. They established that many students replace their phones at least once a year, often replacing broken phones or obtaining updates from network operators. Remaining "fashionable" and the desire to have a phone with longer battery life were some of the other main reasons for the rapid replacement of phones among students.

The survey also reported that about 61% of the students have an additional mobile phone with male students replacing their phones more frequently than their female counterparts (Cited Sarath et al. 2015). According to Ongondo and Williams (2011a), despite the high proportion of students who know the recycling services of mobile phones in the United Kingdom, only a moderate number of them had used the facilities up to that point, the majority of which were female students.

Incentives with a monetary element, such as cash payments and vouchers, greatly influence the willingness of consumers to use mobile phone recycling services, followed by the convenience and ease of use of services (Tanskanen, 2012). It presupposes that money is a catalyst for the recycling of mobile phones and affirms the words of Solomon in Ecclesiastes 10:19 (The Holy Bible, King James Version (2016): 404) that ‘money answereth all things’.

A similar study was carried out by Welfens et al. (2013) about young people in Germany. In their conclusions, they realised that teenagers are very interested in the latest mobile phone models and do not bother with their old mobile phone. They proposed that the creation of awareness among mobile phones users vis-à-vis recycling could change the situation. Yin et al. (2014a, 2014b) surveyed the behaviour of consumers towards mobile phone recycling in China. In their survey, they observed that the average life of a mobile phone in China was less than three years. Most of the consumers were not willing to pay for mobile phone recycling, and the factors that accounted for this were attributed to the region, educational level and monthly income of the respondents (Yin et al.; 2014a; 2014b).

Previous works and other related works on mobile phone recycling indicate that awareness about mobile phone recycling is low in both developed and developing countries (Sarath et al., 2015). To solve these challenges, both governments and mobile phone manufacturers must work together with the recycling industries to develop an adequate system to recycle mobile phone waste (Sarath et al., 2015). To ensure a sustainable mobile phone recycling, the role of consumers should also be given much attention for their willingness to give out their obsolete phones for recycling is another story altogether. In effect, all stakeholders should be engaged in the recycling of mobile phones.

2.7 Exploring the convenience of available mobile phones collection centres

Consumers' awareness of a recycling facility and the proximity of that recycling facility plays a crucial role in whether consumers will patronise the facility or not.

Studies have shown that inconveniences related to the recycling system and economic impediments (for example, return fees and additional trips) reduce the involvement and recycling rate of the mobile phone (Barr et al., 2001; Wagner et al., 2011). These studies also attest to the fact that incentives also boost the morale of consumers to participate in WEEE recycling and for that mobile phone.

Some studies have also shown that there is no link between the availability of a recycling facility and recycling in particular (Miafodzyeva et al., 2013; Ramayah et al., 2012). It presupposes that the availability of a recycling facility might not necessary propel people to recycle their phone Miafodzyeva et al. (2013) surveyed the recycling behaviour of families living in a multi-ethnic urban area in Stockholm, Sweden. In their study, they established that recycling behaviour does not correlate with the facilities provided, but the main motive of consumers participating was the adoption of legal norms (Miafodzyeva et al., 2013). It presupposes that being satisfied with a facility is not a guarantee for participation, but instead, people may participate in a recycling facility when it is backed by law.

Ramayah et al., (2012) conducted a study in Malaysia and established that norms have a significant influence on recycling behaviour of people in society compared to the individual's convenience. Their research also confirms that norms influence the recycling behaviour of consumers.

Wagner (2013) also studied in detail the idea of a convenient collection. The author arguably indicated that collection of WEEE within the extended producer responsibility is

most of the time developed rapidly, and much attention is not paid to how convenient the system will be. Much attention should be paid to convenient collection systems. According to Wagner (2013), the term ‘convenience’, is a subjective construct and individuals have different perceptions of what constitutes a convenient recycling system.

Various types of convenience were suggested by Wagner (2013:3). These include:

- I. Knowledge requirements,
- II. Proximity to the collection point/site,
- III. Opportunity to drop-off materials,
- IV. Inducement of the collection point/site (e.g. desirability or availability of services), and
- V. Ease of the process.

2.8 Some known risks associated with mobile phone recycling

In developed countries with functional electronic recycling systems, mobile phones are recycled in industrial recycling facilities where valuable metals and rare earth are recovered. However, in most developing countries, recycling of e-waste is an informal activity (Oteng-Ababio, 2012a) and it takes place in a very unhealthy environment. Meanwhile, as already noted, mobile phones contain some substances which can be harmful health-wise and environmentally, if their disposal is not properly managed, it may involve processes and conditions that could lead to the release of some toxic by-products (IPMI, 2003).

There are some components and substances in a mobile phone that, under conditions of land disposal, waste incineration and some destructive recycling processes, may pose a risk to the environment (IPMI, 2003). According to IPMI (2003), the electronic circuitry of a mobile phone usually contains a small quantity of tin-lead solder, not less than one-half gram per phone. Lead is a cumulative neurological poison and a probable human

carcinogen, so disposal of the lead in the environment can be a serious health risk (IPMI, 2003).

Again, low contents of lead, cadmium, nickel, and zinc were reported in mobile phone plastics, which suggest that mobile phone plastics do not pose a significant risk for the environment when disposed of appropriately (Silveira, 2010). On the other hand, if these plastics are burned in low, medium temperatures, furans and dioxins can be formed (Nnorom and Osibanjo, 2009a). It, therefore present an issue for developing countries which recycle mobile phones without adequate measures to protect human health and the environment (Silveira et al.,2010). According to (Silveira et al., 2010: 9):

‘The printed wiring board is typically epoxy resin or fibreglass. Both the cases and wiring board are likely to contain inorganic bromine compounds used as a fire retardant, which may contribute to the formation of brominated hydrocarbons in poorly combusted and controlled exhaust gas streams’.

Reuse of a mobile phone does not pose a severe risk to the environment and the life of humans. It extends the lifespan of the phone and its disposal time. The problem is that mobile phones are often reused in deprived areas; hence, they are likely to be disposed of without environmental attention, such as in uncontrolled land disposal which may be a risk to the environment (Skerlos et al.; 2003). According to (IPMI, 2003:6):

‘Land disposal of mobile phones may place them in contact with co-disposed acids, and, over an extended period, the substances that are soluble in those acids may leach out. If the landfill is not bound by an impermeable barrier, these substances may migrate into groundwater, and eventually to lakes, streams, or wells, and raise a potential exposure to humans and other species.

2.9 Perceptions of mobile phone recycling

The word perception etymologically originates from the Latin word, ‘percipere’ (to perceive). Perceived ideas and concepts are seen from two perspectives: first, the conscious recognition and interpretation of sensory stimuli (Allyn and Festinger, 1961) that

serve as the basis for understanding, learning, and knowing a particular action or reaction. The second is the product of the act of perceiving. Perception, therefore, refers to the process of reception, selection, organisation, and interpretation of the individual's information to deduce meaning (Ben-Enukora et al., 2017).

The result of this personal sensory evaluation is manifested in the different interpretation given the same message, depending on personality variables such as beliefs, past experiences, social relations, cultural expectations, and psychological dispositions (Ben-Enukora et al., 2017). The selective process is at the core of perception. Perception of an issue affects the judgement and reactions of an individual towards it (Ben-Enukora et al., 2017). The implication is that peoples' knowledge of and reactions to mobile phone recycling could influence its control.

Education influences perception. Babu et al. (2007) indicated that one of the effective ways to deal with electronic waste and actually, mobile phone waste is education. Perceptual constancy is a term used to describe the properties of objects which remains remarkably constant despite variations in distance, tilt, and retinal locus caused by movements of the observer (Akurugu, 2010). In this light, the perception of people about mobile phone recycling might remain constant irrespective of the efforts made by others to change the perception. Education, therefore, will play an essential role for people to change that perception to give out their phone for recycling and even to contribute some amount of money for the recycling of their obsolete mobile phones.

2.10 History of Mobile Phone in Ghana

The telecommunications sector in Ghana began a major reform in November 1974, when the National Redemption Council Decree No. 311 declared the Post and Telecommunication Department a public corporation (Osikwan, 2008). According to

Osikwan (2008), the department was placed under the authority of the Ministry of Transport and Communications in the same year. According to Osikwan (2008:6)

‘The Accelerated Development Programme (ADP, 1994-2000), which was part of the structural adjustment programme of the World Bank, established the National Communications Authority to regulate the communications industry, by enacting the National Communications Act 524 in 1996’.

Ghana recorded the first mobile phone call in March 1992³. The first call was recorded on Mobitel, which later became Buzz, and now Tigo (Dowuona, 2014). Mobitel was the first company that was granted Mobile Network License to operate at that time. The famous Ghanaian phrase “megyena abontin na miri kasa yi”, which says “I am outdoors as I speak with you” was birthed by Mobitel. (Dowuona, 2014). The license was granted to some Ghanaians who headed Millicom Ghana Limited in 1990 (Dowuona, 2014).

In that year alone, 19,000 Ghanaians owned mobile phones⁴. The number of mobile phone users in 1998 increased to 43,000 and by the middle of 1998 the number increased to 68,000. Between 1999 to 2000 four mobile companies were competing cellular customers, and the usage rose from 22,000 to 132,000 subscribers. Again, mobile phone subscription increased to more than one million in 2004 and to almost 15 million by the end of 2009 (Oteng-Ababio, 2012b). The teledensity (in respect of mobile phone alone) thus grew from about 5 phones to 100 people in 2000 to 49 phones in 2008, an increase of about 190% (Oteng-Ababio, 2012b).

Celltel Limited (which later became Kasapa Telecoms Limited and now Expresso) also received its license to operate in 1993 (Dowuona, 2014). Celltel was granted a license to operate an Advanced Mobile Phone System (AMPS), and it was also analogue with

³ <https://www.myjoyonline.com/opinion/2014/october-7th/nine-licensed-telcos-in-little-ghana-part-one.php>

⁴ <https://www.ghanaweb.com/GhanaHomePage/communication/mobile.php>

850MHz as its frequency. Celltel later moved to Code-Division Multiple Access 2000 1X in 2005 (CDMA 2000 1X) on the same frequency and used to be the only Code-Division Multiple Access operator in Ghana at that time (Dowuona, 2014).

Scancom Limited in 1995 was also given the authorisation to start another Global System for Mobile Communication (GSM) and the first GSM network called Spacefon was started by them in 1996 (Dowuona,2014). Current MTN started with the brand name Spacefon but was later changed to Areeba.

The authorisation was also given to the national landline line operator, Ghana Telecom in 1996 to start another GSM, but they began in 2000 with the brand name One-touch, now Vodafone (Dowuona, 2014). Onetouch was in the hands of the state, but currently, Vodafone owns 70% of the company while the government of Ghana owns 30% of the company. Spacefon at that time sold their Subscriber Identification Module (SIM) cards for 600,000 cedis (GHC60), but Onetouch, which was a network for the prestigious and the elitist in society sold a SIM card for 1.2 million cedis (GHC120) (Dowuona, 2014).

Ghana National Petroleum Corporation (GNPC) joined forces with Western Wireless in the US and secured authorisation for the Wireless Local Loop (WLL) and International Gateway (IG) (Dowuona, 2014). Western Tele systems Limited (Westel) was formed and started operation in 1998 and operated the fixed-line and IG sector. The government of Ghana later bought Westel and secured a GSM mobile license.

No GSM was started over the period until 65% shares of the company were sold to Zain before another GSM was started (Dowuona, 2014). Majority of Zain shares were sold to Airtel, which merged with Tigo recently (Dowuona, 2014). In 2008 another GSM license was granted to Globacom Limited (Dowuona, 2014).

It went through an auction and Glo bought it for US \$ 50.1 million although a Ghanaian

company wanted to buy it, the cost, was too much for the Ghanaian. The company was able to launch the fifth GSM network and the sixth mobile network in Ghana on April 29, 2012. Apart from Glo, all the first five mobile licenses in Ghana were granted to solely Ghanaian companies or some companies with Ghanaian involvement (Dowuona, 2014).

The first Global System for Mobile communication network in the country to operate a 3G network was MTN, but the coverage was confined to the environments of its first Universal Technology System (UMTS) station at Osu in Accra. MTN later walked out of its “hen coop” of a third-generation (3G) coverage when Zain/Airtel launched a 3G network throughout Accra (Dowuona, 2014).

Three companies from Ghana, Surfline Communications Limited, Blu Telecoms Limited and Gold key Telecoms Limited also received authorisation in June 2013 to operate a Broadband Wireless Access (BWA) on the 2500-2690Mega Hertz spectrum, which is suitable for fourth-generation long-term evolution (4G LTE) (Dowuona, 2014).

So indeed, there are now nine licensed telecommunication companies in a relatively smaller country. It appears that the NCA and government for that matter, was more focused on raising money into the consolidated fund, than considering the size of the country’s population in awarding the licenses. But the NCA has often argued that if Ghana was not a profitable telecommunication market, as some often argue, how come the multinationals keep trouping to Ghana even though there were other multinationals already in the Ghanaian market?

The United Kingdom is a more advanced economy with a population of more than 64million inhabitants. It has five major telecommunication companies with nationwide coverage, BT (British Telecom – fixed-line service), Vodafone, EE (everything everywhere), O2 and 3 (Three) (Dowuona, 2014). The United States has four major nationwide telecommunication

companies with a population of more than 320 million. The telecommunication companies are AT&T, Verizon, T-Mobile, and Sprint. But Ghana, with an estimated population of 27million and generally low incomes, has seven active telecommunication companies with two more yet to launch (Dowuona, 2014). And all seven have nationwide coverage licenses. It is therefore not a surprise to find telecommunication companies in Ghana complain of dwindling revenues, and possible mergers as Tigo and Airtel have merged currently. In the second quarter of 2017, 36.4 million Ghanaians were subscribed to various mobile networks (NCA, 2017).

2.11 Legislative law governing e-waste management

The Basel Convention is the first global initiative aimed at tackling WEEE. Khan (2016) argued that the universal environmental law and the evolutionary dynamics of the Basel Convention shows that the treaty works with the Global system to legitimise the trade in electronic waste. There is a possibility that some multinationals play a significant role in transnational waste trade without compromising any form of responsibility and at times, shielding their identity (Khan 2016). It provides avenues for international environmental crime in the global value chain of electronic waste and encourages an increase in abusive conditions in the informal sector (Khan 2016).

The Basel Convention was established in 1989 and enforced in 1992 to combat the increase in the illegal transfer of toxic waste to less-developed nations (Basel Convention, 1989). E-waste was recognised as hazardous under the Convention in 1998. The Basel Convention regulates, rather than bans, the export of hazardous waste (Webster-Main, 2002). The Basel convention should be amended in such a way that hazardous wastes should not be exported from the developed countries to developing countries.

A significant weakness of the Convention is that the prior informed consent fails to ensure that the exporting country adequately verifies that proper waste management facilities are available in the importing country (Widawsky, 2008). Even though the law places a responsibility on both the importer and the exporter to ensure that there are adequate facilities in the country of disposal it does not propose a particular process through which the information can be ascertained (Alan, 2009). Most of the developing countries lack the technical and administrative capacity to verify the level of risk which may be posed by the shipment of a particular type of waste they may give consent to (Widasky, 2008). Measures to reduce toxic materials in mobile phones are another crucial policy component for any legislation on mobile phone recycling.

2.12 Policy Framework on E-waste in Ghana

Ghana, like most developing nations, is plagued with problems when it comes to managing waste of all kinds. There have been various attempts since the introduction of the 1992 constitution to increase the countries capacity to address its waste problems both through the establishment of institutions, policy framework and regulations.

The emergence of electronic and electrical waste has also brought to the fore the need to refocus policy direction to inculcate the management of e-waste in the waste management practices, mainly due to the hazardous nature of e-waste. This section of the chapter examines past and present policies and regulations for managing electronic waste and what has been the experiences so far in their implementation in Ghana.

2.12.1 The 1992 Constitution of the Republic of Ghana

The 1992 Constitution of Ghana provides the policy basis for the protection of the environment. The important parts of the constitution that address these are the following (Cited Atiemo et al., 2016:33):

- i. Article 36 (9): The nation shall take the necessary actions to defend and protect the surroundings of the state for future generations and join other nations and agencies that matter with the intention of preserving the global environments for humanity;
- ii. Article 36 (10): The State shall protect the health, safety and the welfare of all working people, and shall establish the basis for the full deployment of the creative potential of all Ghanaians; and
- iii. Article 41 (k): It shall be the duty of every citizen to protect and safeguard the environment since enjoyment of human rights and liberties cannot be separated from the fulfilment of responsibilities and duties

It presupposes that the protection of the environment per the 1992 constitution does not lie only in the hands of the state, but citizens also have a crucial role to play to safeguard the environment for humanity.

2.12.2 National Environmental Policy

In 1991 the National Environmental Action Plan (NEAP) was issued, and it includes the Environmental Policy of Ghana. The policy seeks to improve upon conditions of people, surroundings and the worth of life for posterity (Atiemo et al., 2016). The policy requires that the state takes the necessary steps to manage toxic waste and the importation of substances which contain toxic substances (Example, Electrical Electronic Equipment). The National Environmental Action Plan seeks to address, among others the following:

- i. Safeguard the natural resources and the environs from dangerous and unhelpful practices;
- ii. Ensure that growth is in agreement with the requirements to avert, lessen, and as much as possible eradicate toxic waste;
- iii. Integration of issues concerning the environment at every facet of growth; and

- iv. Ensure that environmental challenges are resolved collectively in the sub-region and the rest of the world.

In effect, NEAP offers the basis for managing possibly dangerous materials, which consist of EEE in Ghana (Ateimo et al., 2016)

2.12.3 International and Multilateral Environmental Agreements

Ghana has given its consent to several multilateral environmental agreements (MEAs) related to chemicals and waste and has adopted several international codes and declarations as cited in Ateimo et al., (2016: 24). These include the following:

- i. ‘The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes which was designed to reduce the movements of hazardous waste among nations and precisely to prevent the transfer of hazardous waste from industrialised countries to the least-developed countries’;
- ii. ‘The Vienna Convention on Protection of the Ozone Layer was adopted to encourage collaboration through systematic observations, research and information exchange on the effects of human activities on the ozone layer and adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer’;
- iii. ‘Montreal Protocol on Control of Substances that Deplete the Ozone Layer was designed to promote the ozone layer by phasing out the production of many substances that are responsible for ozone depletion’;
- iv. ‘The Rotterdam Convention on the Prior Informed Consent (PIC) is a means to officially obtain and disseminate the information so that decisions can be made by importing countries as to whether they wish to receive future shipments of certain chemicals and for ensuring compliance with these decisions by exporting countries’

- v. 'Hazardous Chemicals and Pesticides in International Trade aims to encourage shared responsibility and cooperative efforts in the global trade of certain hazardous chemicals and insecticides to safeguard human health and the environment';
- vi. 'The Stockholm Convention on Persistent Organic Pollutants is an international agreement to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or the environment.';
- vii. 'ILO Convention on safety in the use of chemicals at work' aims at "making work more human". The convention is concerned with improving the quality of working life in all aspects: for example, the prevention of occupational accidents and diseases, the improvement of the content and organisation of work and conditions of employment in general ;
- viii. 'London Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer seeks to strengthen the control procedures under the Montreal Protocol on substances that deplete the ozone layer (1987) to extend the coverage of the protocol to new substances and establish financial mechanics for the protocol';
- ix. 'World summit on sustainable development in Johannesburg also seeks to improve people's lives and preserve our natural resources in a world that is growing in population, with ever-increasing demands for food, water, shelter, sanitation, energy, health services and economic security';
- x. 'The Rio Declaration on Environment and Development - Agenda 21 seeks to protect the integrity of the international environment and development system. It

also reaffirms the declaration of the United Nations Conference on human-environment which was adopted at Stockholm on 16th June 1972'; and

- xi. 'The Strategic Approach to International Chemicals Management (SAICM) is an international policy framework that seeks to ensure sound management of chemicals to achieve sustainable development, including the eradication of poverty and disease'.

2.12.4 Specific WEEE Management Legislations

Even though there have been some acts and systems that have some link to the management of toxic substances in Ghana but they do not address the risks posed to lives and the environment in general (Atiemo et al., 2016). The Environmental Protection Agency (EPA) Act, 1994 (Act 490) is what has some close link to the management of Waste Electrical and Electronic Equipment '*which established the EPA, with the obligation to control, organise and manage the environment*' as cited in Atiemo et al., (2016:24). Part two of the law requires the Environmental Protection Agency to:

- i. 'Provide standards and guidelines about the pollution and the discharge of toxic wastes and control of toxic substances ';
- ii. 'Coordinate activities and control the generation, treatment, storage, transportation and disposal of industrial wastes '; and
- iii. 'Control the volumes, types, constituents and effects of waste discharges, emissions, deposits or other sources of pollutants and/or substances which are hazardous or potentially dangerous to the quality of life, human health and the environment '.

Section 10 of the Law establishes the Hazardous Chemicals Committee required to monitor the use of hazardous chemicals by collecting information on the import, export, manufacture, distribution, sale, use and disposal of such chemicals (Atiemo et al., 2016).

This law does not provide a specific reference to Waste Electrical and Electronic Equipment but provides a framework for the handling of hazardous substances (Atiemo et al., 2016).

Other Acts with some link with the management of WEEE in Ghana include the following as cited in Atiemo et al., (2016:25):

- i. The Factories, Offices and Shops Act, 1970 (Act 328). The Act deals with the registration of factories and also mandate factories to indicate the number of male and female employees. Factories were to also indicate the welfare facilities available at their sites. The Act specifically seeks to protect workers from hazardous substances;
- ii. ‘The Standards Act, 1973 (NRCD 173) is a statutory board responsible for testing, inspection, metrology and certification. The body was mandated to promote standardisation in industry and commerce ;
- iii. ‘The Mercury Act, 1989 seeks to regulate the import and trade of mercury and established it as an offence the use of mercury in bad mining practices ’;
- iv. ‘Merchant Shipping (Dangerous Goods) Rules, 1974 (LI 971) seeks to restrict trading on Ghanaian waters, registration, building, importation and licensing of ships and propriety interest in ships’;
- v. ‘Customs, Excise and Preventive Service Law, 1992 (PNDCL 330) seeks to consolidate existing laws relating to the operations as well as the administration of the erstwhile Department of Customs and Excise’;
- vi. ‘Local Government Act, 1992 (Act 458) was established to regulate local government system per the constitution’;
- vii. ‘Export and Import Act, 1995 (Act 528) was established to ensure that anybody who exports goods fills the exchange control form A2 and endorsed by any bank and anybody who imports goods completes an import declaration form’; and

- viii. ‘Environmental Assessment Regulations, 1999 (LI 1652) seeks to improve the surroundings, living conditions and quality of life of all citizens, both present and future generations and seeks to ensure reconciliation between economic development and natural resource conservation.

2.12.5 Regulations on the import and end-of-life management of refrigerators, freezers and air conditioners

The Government of Ghana adopted Regulation, 2008 (L.I.1932) to ensure the efficient use of electrical appliances and also protect the environment. The legislative instrument banned the importation of used refrigerators and freezers in Ghana. The ban was implemented in January 2013 after an extensive deliberation with all the major stakeholders (Atiemo et al., 2016).

Within the sub region, Ghana was the first country to ban the importation of old fridges. The ban was to reduce the amount of chlorofluorocarbons (CFCs) release onto the ozone layer and also reduce load of energy on the national grid (Atiemo et al., 2016). The ban was as a result of a study conducted by the Energy Commission which revealed that most used refrigerators and freezers consume twice as much energy like new ones (Atiemo et al., 2016).

The L.I. (1932) made it a felony to (a) move a used fridge, sell or distribute to any other person. The Energy Commission was mandated to search and confiscate such appliances and destroy them within four weeks (Atiemo et al., 2016).

The Energy Commission tasked a private company to set up a refrigerated recycling plant to destroy all sized fridges and air conditioners at Afienya near Tema in the Greater Accra region. Again, anyone who violates this legislative instrument is fined or faces a prison sentence if the person fails to pay the fine.

2.12.6 Hazardous and Electronic Waste Control and Management Act, 2016 (ACT 917)

Laws that govern electronic waste can be entirely ineffective when it is designed without meaningful consideration of the socio-economic realities of e-waste recycling. A case study is India's e-waste law which was adopted in 2012 despite the concerns of internal human rights warning of the negative effect on the 80,000 people working in India's informal recycling sector and their families (Khan, 2016).

In 2010, the government of Ghana as part of efforts to address the emerging challenges associated with the e-waste conundrum developed the Hazardous and Electronic Waste Control and Management Bill. After going through deliberations with stakeholders, it was eventually passed in 2016 by an Act of parliament and currently known as the Hazardous and Electronic Waste Control and Management Act, 2016 (ACT 917).

The current Act seeks to address the e-waste problems by looking at among other things the importation, exportation, transboundary movement, disposal, and management of hazardous waste. It also introduced a levying arrangement, an e-waste fund and a recycling plant to recycle e-waste products in the country. The long term plan is to among other things manage e-waste sustainably, build the capacity of the country both in terms of technological development and human resource development since the expectation is that jobs will be created in the process.

In terms of specific provisions in the Act, the section on the importation of hazardous waste specifies that the country from which the hazardous substance is being imported from should be a party to the Basel Convention and adhere to rules as stated in the convention with regard to the transboundary movement of electronic waste. Again, the Act also

specifies that approved sites or facility where e-waste will be disposed should be capable of managing and disposing of waste in an environmentally friendly manner.

Concerning the section on the levying, the importer of electronic equipment or a manufacturer of it is required to register and pay a levy to the agency which will be used for purposes of collection, treatment, disposal, and recycling of electronic waste. The fund which will be set up through a public-private partnership arrangement will be used in constructing the treatment plant, for funding research into e-waste management and education and capacity building.

Part two of the Hazardous and Electronic Waste Control and Management Act (Act 917) mandates the establishment of Electrical and Electronic Waste Management Fund. The establishment of Electronic Waste Levy and Electronic Waste Recycling Fund implies that all operational responsibilities for e-waste management and recycling will become a government responsibility rather than a producer responsibility (StEP, 2012).

Ghana's e-waste law will have a lot of challenges since the management and recycling of e-waste is a government dominated activity; producers will produce without taking into consideration the kind of materials they use. This is because they are not going to manage the waste that will be generated from their activities. In the EU Directive, the producer has specific responsibilities in the products end-of-life span.

The role of the informal sector seems to be missing in this Act. The Act puts the informal sector in an invisible arrangement along the e-waste value chain. The new law does not make provisions about how those in the informal sector can sustain their activities and formalised their operations.

Khan (2016) indicated that the current social arrangements that surround e-waste exchanges between the formal and informal sector both at the local and transnational scales are buried

underneath Ghana's e-waste Act, 2016 (Act 917). The new e-waste law presents new threats to the livelihood of informal workers because it does not clarify their engagement as stakeholders in a sustainable e-waste economy.

Article 15 demands that generators, collectors, storers, transporters and disposers of hazardous waste and other waste to maintain adequate insurance cover (StEP, 2012). This aspect of the law is very important, but it will be difficult for small scale collectors because most of them are the unprivileged urban poor (StEP, 2012).

Article 13.2 indicates that "The Agency shall ensure that hazardous wastes are not mixed with non-hazardous waste unless the generator, collector, storer, transporter or disposer proves that the mixing is more environmentally sound". There is some problem with this article in the sense that it will allow hazardous waste to be diluted with non-hazardous waste. The question is, does the agency have the necessary tools to ascertain whether the hazardous waste is not mixed with non-hazardous waste? It should be the responsibility of the generator, collector, storer, transporter or disposer so that when they breach it, the agency can deal with them.

To conclude, Ghana's Hazardous and Electronic Waste Control and Management Act, 2016 (Act 917) is a significant step. But the success of this new Act is questionable because the most marginalised social groups whose livelihood depends on the waste economy is not spelt out clearly in the new law.

2.13 Theoretical framework

To unpack the objectives set for this work, the theory of planned behaviour by Ajzen (1988) was chosen as the theoretical basis for the study. In the very least, Ajzen's work lends credibility to the study by asserting that the findings will be adding to the intellectual body

of knowledge about a subject matter that has been researched and hypothesised about other academics.

2.13.1 An overview of the Theory of Planned Behaviour

The TPB was developed from the earlier Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1980). The TRA was specifically based on two common premises. First, the TRA indicated that individuals act reasonably and hence, process and use available information before acting. The second proposition also states that intentions are determined by attitude towards the specific behaviour and subjective norms. Though the Theory of Reasoned Action has demonstrated a remarkable predictive value in many applications in social and behavioural sciences, it has been criticised because the TRA assumes that the target behaviour is based wholly on an individual volitional control. That is, the individual has all the conditions to perform the task in question.

The Theory of Planned Behaviour (TPB) is one of the most widely used theory for explaining human behaviour and actions among scholars, not only within the behavioural science but also in the broader social science disciplines (Staats et al., 2003). Further, it has also been used in studying or exploring pro-environmental behavioural patterns such as energy conservation, water conservation, recycling, travel mode to mention a few. The TPB was developed from the earlier Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980)

The TPB provides an acceptable theoretical framework for systematically identifying the factors which influence the recycling decision and several studies have confirmed its utility for investigating the determinants of recycling behaviour (See for example Boldero, 1995; Cheung et al., 1999; Taylor & Todd, 1995a, 1995b). There are two reasons for the adoption of the TPB. First, it allows relationships of direct and indirect nature among five relevant

predictors of recycling in previous research in the field: 1 attitudes towards the act (Cheung et al., 1999; Taylor and Todd, 1995a, 1995b) 2 subjective norms (Hopper and Nielsen, 1991; Pelton et al 1993); 3 perceived behaviour control (Cheung et al., 1999; McCarthy and Strum, 2001); 4 specific knowledge about what, how, where and when to recycle (Corral-Verdugo, 1996; Gamba and Oskamp, 1994); 5 perceived performance and convenience of the provided logistics service (Austin et al., 1993; Leroux, 2000).

Secondly, the prediction ability of this theory is more accurate when specific attitudes towards the behaviour in question are considered rather than moral and global attitudes. In terms of recycling, and for that matter mobile phone recycling, general attitudes toward the environment are not necessarily significant (direct) determinants of recycling participation.

According to Ajzen (1988), the TPB is based on the premise that people's behaviour can be predicted if their intentions about that behaviour are known. While intentions are good predictors of behaviour, the theory further posits that there could be barriers that may impede people from carrying out what they intend to do. These barriers could be internal or external. Internal may be unique qualities that are required in carrying out one's intention and include skills, information available, level of education, age and other personal characteristics. The external barriers include policies available, access to infrastructure that can facilitate the realisation of the intention, among others.

Intentions are assumed to capture the motivations that influence the conduct of people's behaviour (Ajzen, 2011). It also shows how determined they are to undertake certain actions. Further, even though the intention to undertake such behaviour may be there, it should go hand in hand with other non-motivational factors such as availability of resources such as time and money (Ajzen, 1991). Thus the outcome of a behaviour is the ability or opportunities that facilitate the realisation of the behaviour.

The theory explains that intentions are in themselves influenced by three factors. The first is the attitude toward behaviour. It refers to people's opinion about their self of the behaviour. According to Ajzen (1991), this also relates to one's appraisal or evaluations of how favourable or unfavourable the behaviour in question. The second determinant of intention is what is called subjective norm (Ajzen, 1991). It refers to the opinions of others about the behaviour in question. The perceived subjective norm may include social and external pressures that may impact on a behavioural outcome (Ajzen, 1991).

It may also relate to the socially expected mode of conduct, which can influence people's motivations and invariably, the outcome of their behaviour. The last point which is perceived behavioural control refers to the extent to which people believe that they can perform a particular behaviour. Perceived behavioural control hinges on the capabilities of people and the belief in their potential in executing conduct or behaviour. In essence, the TPB argues that individual self-interest and motivation is the most important determinant of human behaviour (Cameron et al., 2012). The self-interest and motivation is a cognitive process that is intended to arrive at a decision which provides a rational basis for the behaviour (Cameron et al., 2012).

It accepts the complexity of human behaviour and places it at the interface of a range of factors acting on it at different levels. It includes internal or individual level factors or contextual factors. The TPB, however, allows for the incorporation of additional variables, provided these variables make a significant contribution to the explanation of the behaviour provided by the model (Ajzen, 1991). The original framework was modified by incorporating subjective norm. Subjective norm includes social and external pressures that may impact on a behavioural outcome.

In relating this to consumer's attitude toward recycling, it can be argued that the motivation to recycle is based on people's intention about the value of recycling or the importance that they place on recycling obsolete mobile phones.

Further, the decision to recycle mobile phone will also be based on evaluation of social practices, how policies encourage them to give out their mobile phones for recycling and how this practice has been done within the context of the Ghanaian society. Further, giving out obsolete mobile phones for recycling will also be based on the limitations and barriers which is also at play at the policy or institutional level.

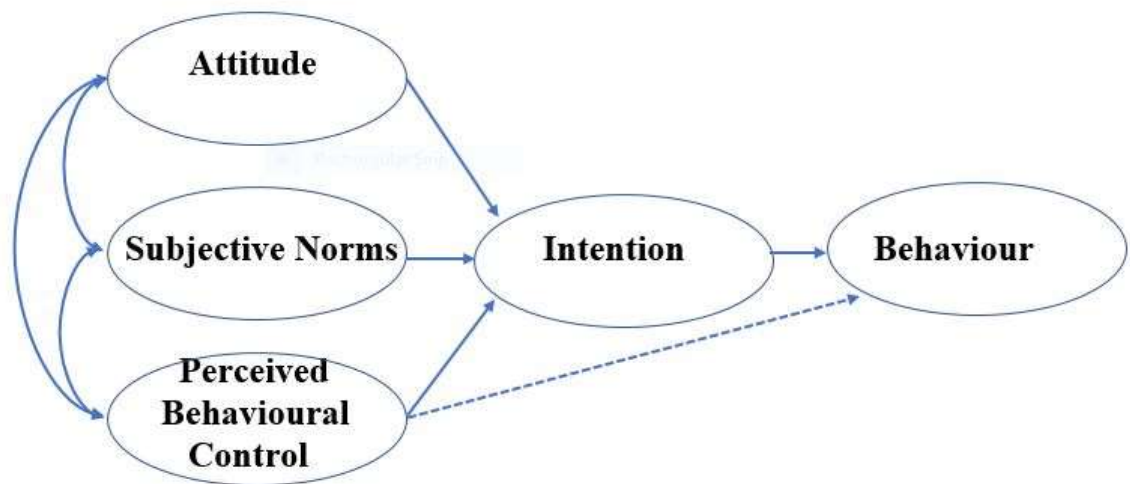


Figure 2.1: Theory of Planned Behaviour

Source: Ajzen (1988)

2.14 Summary

This chapter explained the recycling of mobile phone, prospects, and challenges of mobile phone recycling, consumer behaviour towards mobile phone recycling, the convenience of recycling and mobile phone collection, and risks associated with mobile phone recycling. The study conceptualised mobile phone recycling as a behavioural issue; hence, the theory of Planned Behaviour was used to explain the recycling of mobile phone.

CHAPTER THREE

STUDY AREA AND RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed the study area and the research methodology adopted for the study. The first section described the profile of the study area (Metropolitan Accra) including its economy, population dynamics, the profile of the three selected communities, and map of the study area and ownership of mobile. The other section of the chapter presents the research methodology that was employed to collect relevant data for the study and the justification of materials and methods used for the study. The procedures and techniques for the study covered the choice of research paradigm, data sources, research design, target population and sample size determination and sampling procedure, data analysis technique, reliability and validity of the study.

3.2 The study Area: Metropolitan Accra

Accra Metropolitan Area (AMA) as currently defined includes Nima, Airport Residential and Osu.

3.2.1 Background to the study

Accra, the capital of Ghana, has grown rapidly both physically and economically. The origin of Accra has been related to its development as a coastal fishing port in the late sixteenth century by many experts (Grant & Yankson, 2003). The Kpesi were the first settlers on the stretch of the coast which is current Accra. They included the Ga-speaking migrants from Niger into their communities. The east of the fishing village was east of the Korle lagoon but later expanded to include places like Jamestown and Ussher Town in the present-day Accra (GSS, 2014).

Accra is bounded on the north by Ga West Municipal, on the west by Ga South Municipal, on the south by the Gulf of Guinea and the east by La Dadekotopon Municipal (GSS, 2014). Metropolitan Accra covers a total area of 139.674 km² (GSS, 2014). The research was conducted in Metropolitan Accra because the area is famous for its large scale economic and commercial activities. Metropolitan Accra is also a hub of mobile phones in Ghana. The largest informal e-waste recycling site –Agbogbloshie is found within the Metropolitan area

3.2.2. The Economy of Metropolitan Accra

Generally, Metropolitan Accra has the largest local economy in the country and contain most local parastatal companies and multinational cooperation (Grant, 2001). Metropolitan Accra is the commercial centre of the Greater Accra Region and the rest of Ghana (GSS, 2014). Important institutions like telecommunications, industries, oil companies, recycling companies etc. are found in the Accra Metropolis (GSS, 2014). Accra is also well known as a major hot spot for informal e-waste recycling activities (Atiemo et al., 2016). The private informal sector is the primary avenue of employment in Metropolitan Accra for 74.0% of the populace are employed in this sector (GSS, 2014). The private formal sector also employs (16.9%) of the people (GSS, 2014). From the above results, the private informal and formal sectors are the major employees of the Metropolis (GSS, 2014).

The public sector employs 7.8% of the populace. The proportion of males (9.8%) employed in the public sector is higher than females (5.9%) in the Metropolis (GSS, 2014). More than a third (35.2%) of the total population in the Metropolitan Area work in the wholesale and retail, repair of motor vehicles, mobile phones, and motorcycle categories (GSS, 2014). Of this number, women constitute the highest proportion (41.2%). From the available data, it can be deduced that women prefer working in those industries. More males (8.3%) are in the construction industry compared to females (0.3%).

3.2.3 The population dynamics of Metropolitan Accra

The population of the Metropolitan Area grew from 636,667 in 1970 to 969,195 in 1984 as cited in Ofori-Atta (2015), and then to 1,665,086 in 2010 (GSS, 2014). The projected total population of the Metropolis for 2019 was 2,087,668 (GSS, 2019) with women representing 51.9%, while men are 48.1%. The age distribution of the populace indicates that the population peaked in the 20-24 age range, which represents 12.4%, followed by the 25-29 age range (11.5 per cent). The population trend in Metropolitan Accra reflects the national population where women (51.9) are more than men (48.1) in nearly all the age groups. The overall sex ratio of male to female in Metropolitan Accra is 92.7% (GSS, 2014).

The sex ratio of Metropolitan Accra is less than the national proportion of 95.2% (GSS, 2014). The Metropolis has a total fecundity rate of 2.2, which is lower than the regional average of 2.6%, while the gross mortality rate is 4.4% per 1000 inhabitants, which is a little higher than the regional average of 4.3% per 1,000 inhabitants (GSS, 2014). Accra's average gross population density is 250.73 people per hectare compared to 607.8 per hectare in slum communities (AMA, 2011). The dependency ratio in the Metropolis is 48.5% which is less than the regional (53.4) (GSS, 2014). From the available data, it can be deduced that there are few non-working people being catered for by the economically active population in the Metropolis.

Again, 47% of the population were migrants, where 27.8% had migrated from the Eastern region while the least (1.2%) were from Upper West region (GSS, 2014). With the migrant group, 14.5% had lived in the Metropolis for less than a year, 26.1% had resided in the Metropolis between 1-4 years while 21.4% had lived there for more than twenty years (GSS, 2014). The highest ratio of international migrants had resided in the Metropolis between 1-4 years.

3.2.4 Profile of Nima, Osu and Airport Residential Area

The three communities chosen for this study was based on their socio-economic classifications spanning from high-income community (Airport Residential Area), middle-income community (Osu), and Nima being a low-income community (Songsore et al., 2009; Yankson & Bertrand, 2012; Agyei-Mensah & Owusu, 2010). It was to appreciate the spatial variation of the prospects and challenges of mobile phone recycling and reuse based on class and income status. By observation, each of these three communities has various characteristics in terms of pattern of building, economic activities, level of education among

The available information suggests that Nima is a highly dense, culturally diverse and local economy characterised by low skills and unemployment among young people, and the others. Airport Residential Area is well planned compared to the other two communities. Airport Residential is the most developed, followed by Osu and Nima being the least developed. The population of the three communities when put together is 145,382.

Nima is the community with the largest population (80,843), followed by Osu (59,460) and Airport Residential Area the least (5,079) majority of residents have low incomes (Songsore et al., 2005). At Nima, income levels are generally low since most residents only have poorly paid jobs as a result of their little formal education (GSS, 2014). According to the 2000 population and housing census of Ghana, the population of Nima was 69,044 as cited in Owusu et al. 2008).

But in 2010 the population of Nima grew to 80,843 (GSS, 2014). From the data, it can be deduced that within the spate of ten years 11,799 people were added to the population of Nima. Nima has high population density (GSS, 2014).The 2010 population and housing census provide an idea of the heterogeneity of the current population of Nima. The

population of Nima has similar characteristics with Osu. This is because the population of Nima also peaked at the age group of 20-24 with 9,824 people (GSS, 2014).

Osu is about 3km east of the central business district. The percentage of the economically active group in Osu is 69.5% with 40,124 males and 44,462 females (GSS, 2012). The indigenes are into fishing and petty trading as their economic activities. Osu is known for its busy commercial, restaurants, and nightlife activity. The population of Osu is 59,460 with 28,113 males and 31,347 females (GSS, 2014). The youth and the economically active age group is high compared to the dependent group; thus, children and the aged. The population peaked at the age group 20-24 with 6,716 people.

Airport Residential area is about 10km northeast of the city centre and is closed to the Kotoka International Airport. The area is mostly inhabited by rich Ghanaians and foreigners. It has many offices including those of international NGOs, many embassies, schools and shops⁵. Airport residential, on the other hand, has different population dynamics. With the exception of children (0-14 years), all the age groups have higher male population as against female population. In effect, males have a higher population (51.5%) compared to females (48.5%) (GSS, 2012). Airport residential area has a population of 5,079 (GSS, 2014). Some factors that might have accounted for this population dynamics include higher education, late marriage and the choice of smaller family size.

⁵ <https://buzzghana.com/10-expensive-luxurious-places-accra/>

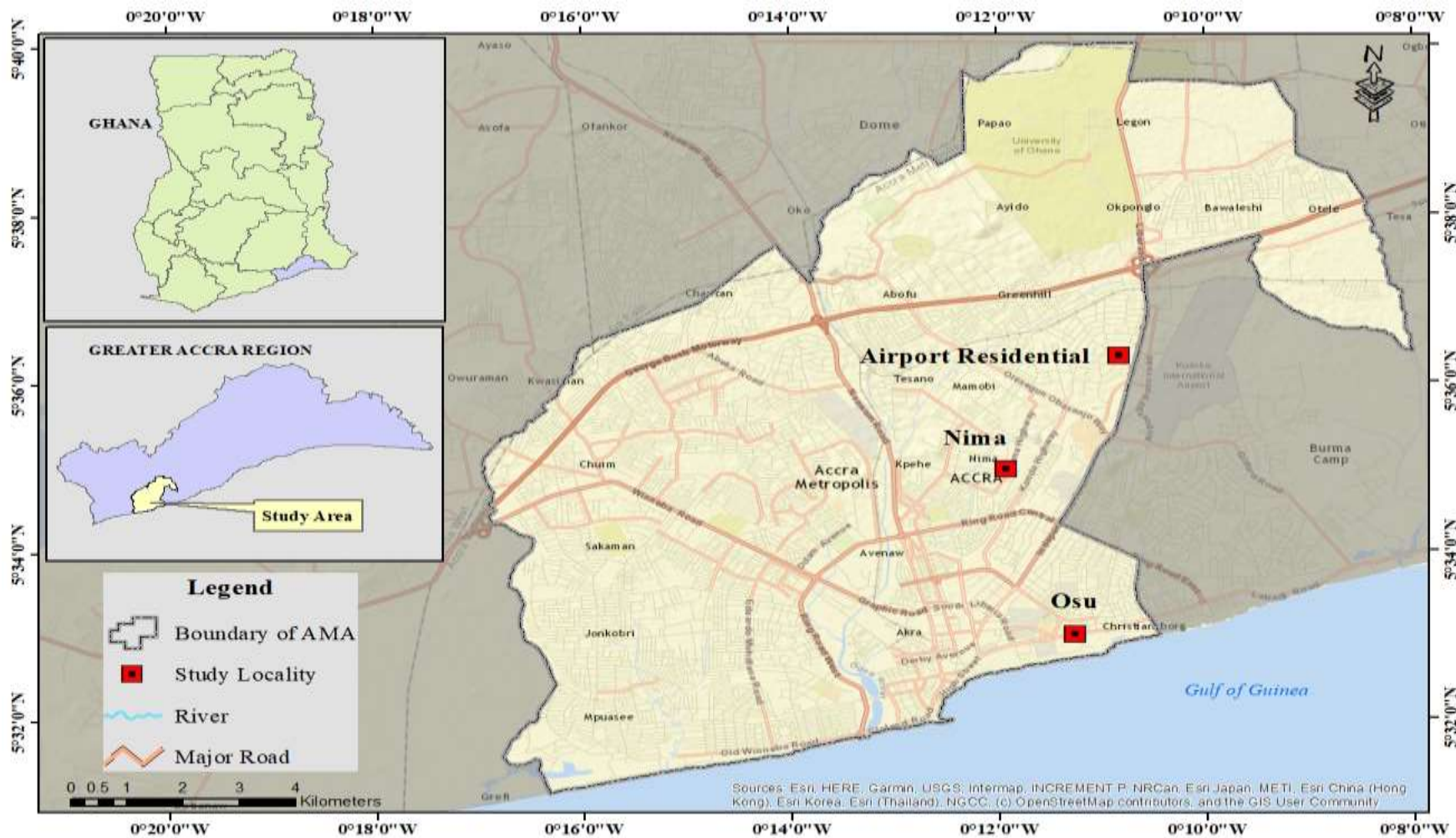


Figure 3. 1: Map of Metropolitan Accra
Source: Author's construct

3.2.5 Current ownership of mobile phone in Metropolitan Accra

Of the 1,275,440 inhabitants who use ICT in Metropolitan Accra, 75.4% had cell phones compared to 73.5% in the region. More females (50.1 per cent) than males (49.9) per cent owned mobile phones in the Metropolis (GSS, 2014). It may be attributed to the fact that men buying mobile phones for women is higher than women purchasing mobile phones for men.

3.4. Research paradigm

The study was inspired by the philosophical underpinning of pragmatism, where the researcher had the opportunity to choose from both quantitative and qualitative approaches without restrictions (Creswell, 2014). Pragmatists claim that researchers must stress on the research problem and adopt multiple strategies to develop knowledge about the problem. As argued by Saunders et al. (2007), there is no one point of view that can ever give the perfect picture since there may perhaps be several realities. The pragmatic paradigm was adopted for this study because it aligns with the mixed methods approach. The pragmatic paradigm was suitable for this study because it has what Tashakkori and Teddlie (1998) and Creswell (2014) see as intuitive appeal, permission to study areas that are of interest, embracing methods that are appropriate and using findings in a positive manner in harmony with the value system held by the researcher.

3.5 Sources of Data

When carrying out research, data could be sourced from different places or angles depending on how relevant it is to the quality of information needed by the researcher. The study used two main data sources. They were primary and secondary data. The primary data was sourced from questionnaires, in-depth interviews, and observations. The quantitative data was sourced from respondents using questionnaires while the qualitative data was sourced from key informant interviews with stakeholders from the public and private sector.

Notes were taken from observations during the fieldwork. The secondary data were sourced from journals, books, conference paper presentations, articles as well as published and unpublished theses and dissertations mainly on mobile phone recycling and reuse, prospects and challenges of mobile phone recycling, and research methods.

3.6. Research design

A research design is the master plan of an investigation that sheds light on how the study will be carried out. It shows how all the main parts of the research study (the samples, measurements, programs, etc.) work together in an attempt to address the research questions. It is similar to architectural design. The study employed a cross-sectional survey where questionnaires, in-depth interviews, and observations were used to assess mobile phone recycling and reuse and the potential prospects and challenges associated with mobile phone recycling in Metropolitan Accra. A cross-sectional survey collects data about a population of interest at one point in time.

The study adopted a mixed-method approach. According to Creswell (2014), the mixed-method approach combines both quantitative and qualitative forms. The choice of this design was also based on the understanding of the inherent weaknesses associated with the use of a quantitative or qualitative approach (Creswell, 2014).

Teye (2012), indicated that the quantitative method is useful for generalisations and prediction but is not suitable for explaining behaviour and perceptions. Qualitative research which involves in-depth interviews, focus group discussions, and participant observation are very good for generating detailed data on the experiences, perceptions, emotions, beliefs and behaviour of respondents but too subjective (Teye, 2012). The advantages of using the mixed-method in a single investigation include the following; it helps one method to

complement the other, and one can seek convergence and corroboration (Johnson & Onwuegbuzie, 2004).

There are some weaknesses with the use of the mixed-method strategy despite its advantages. Johnson and Onwuegbuzie (2004) pointed out that the combination of quantitative and qualitative approaches in a single investigation can be time-consuming and costly. Besides, analysing both data and interpreting conflicting results can be very challenging. However, the study adopted the mixed method strategy to collect detailed information due to the complexity of the subject.

The sequential exploratory method was adopted for this study. According to Creswell (2014), this approach of mixed methods involves starting with the qualitative and then following through with the quantitative. The interview was first conducted (i.e. qualitative). The interview was conducted first because I wanted to have first-hand information about mobile phone recycling. Quantitatively, the questionnaire was used to gather information on the socio-economic background of households, prospects and challenges of mobile phone recycling, regulatory policy for managing mobile phone waste, perceptions and attitudes of respondents towards mobile phone recycling.

Qualitatively, the interview was used to solicit information from Environmental Protection Agency personnel, recycling companies, mobile phone repairers, and collectors of used phones and RLG to understand the prospects and challenges of mobile phone recycling, as well as gain more insight on the regulatory policy for managing mobile phone waste. The risks associated with the manual disassembly and recycling was also sought from the recycling companies and mobile phone repairers.

3.7 Target Population

The target population refers to the set of the unit to be studied (UNODC, 2010). The target population for this study was household heads in three selected neighbourhoods in Metropolitan Accra. The household head was selected for this study because they were in a position to give me essential information concerning how mobile phone waste is handled by the family, including how they are disposed of. Again, if there is an arrangement with a mobile phone takeback service, such arrangement will be made with the household head, and for this reason, the head of the household will be the appropriate person to solicit information from in terms of how mobile phone waste is handled by the household. Recycling companies, mobile phone repairers, dismantlers of non-functioning phones, EPA officials and mobile phone collectors were also considered for this study.

3.8 Sample Size Determination and Sampling Procedure

3.8.1 Quantitative Study – Questionnaire survey

According to Kumekpor (2002), self-administered questionnaire is less expensive than sending interviewers to the field, especially when respondents are scattered over an area. Self-administered questionnaires was used to collect data for the survey because the respondents were scattered at Nima, Osu and Airport Residential Area.

The semi-structured questionnaires was administered to household heads who use mobile phone. Specifically information was sought from household heads demographic and socioeconomic characteristics, type of work, history of mobile phone use, the lifespan of mobile phone, replacement of mobile phone, how incentives can boost their willingness to recycle mobile phone, and consumers' attitude towards mobile phone recycling. The questionnaire was pre-tested to a sample of twenty (20) household heads who use mobile phone by simple random sampling at East Legon. This small size was guided by the

suggestion by Fink (2003b in Saunders et al 2007) that the minimum of ten (10) for pretesting is adequate for student questionnaire.

I personally administered most of the questionnaires, and this partly contributed to the high response rate. I was able to ask questions in the local languages, where necessary. Direct administration of the questionnaire also ensured a low incidence of missing cases. Again, by administering the questionnaire directly, I was able to ask more probing questions as a follow up to some interesting answers that emerged. This was very important since some of the questions were open-ended. Responses were noted down on each questionnaire.

A total of 272 questionnaires were distributed to households based on the classification of residential areas in the GAMA (Songsore et al., 2009). It was to appreciate the spatial variation of mobile phone recycling, reuse and the potential prospects and challenges based on class and income status in the Accra Metropolis. The population of the three study areas when combined amount to 145,382. The individual population of the three study communities was as follows 59,460 for Osu, 80,843 for Nima and 5,079 for Airport residential area.

To obtain a sample size of the population, the study adopted Fisher *et al.*, (1998) formula. Since a finite population (N) is difficult to obtain, assuming a normal distribution and taking into account the parameters for the analysis and interpretation of the data, the formula was appropriate for the study. Fisher *et al.* (1998) formula,

$$\text{Thus } n = \frac{z^2 pq}{e^2}$$

Where:

n = Sample size (when the population is greater than 10,000)

z = Standard normal deviation (mostly set at 1.96 corresponding to 95% confidence)

p = Proportion of the target population estimated as having particular characteristics

$$q = 1.0 - p$$

e = Level of precision, computed as: 100% - 95% = 5% or 5/100 = **0.05**

With (z) statistic being 1.96, level of precision (e) set at 0.05. The proportion of the target population with a particular characteristic (p) is set at 50% (0.5).

$$n = \frac{1.96^2 * 0.5 * 0.5}{0.05^2}$$

$$= \frac{3.8416 * 0.25}{0.0025}$$

$$= \frac{0.9604}{0.0025}$$

$$= 384.16$$

$$= 384$$

$$= 384$$

$$n = 384.16 \text{ (384)}$$

A total of 384 sample size was derived from Fisher *et al.* (1998) formula. However, due to time constraints, limited resources, unwillingness and unavailability of some respondents, 272 respondents were chosen for the study. The calculation was done using the level of precision and the confidence interval (Israel, 2003). The level of precision refers to the true range in which the population is estimated to be. For instance, if the confidence interval is ± 5 , then what this means is that if 60% of respondents expressed an opinion on an issue, then the true value is about 55% to 65% of the true population.

In arriving at the sample size for the three residential neighbourhoods, a proportional representation method was used in the allocation of the sample. To get the sample size being distributed for the three communities, the proportion method by Bowley (1926) was adopted which is;

$n = \frac{P}{TP} * S$ where, n= number of the sampled respondent, P=Household population of a particular community, TP=Total household population of the three communities, S= Total sample size for the study.

Table 3.1 Distribution of Respondents in Selected Communities: Nima, Osu and Airport Residential

Community	2010 population	Sample Size	Adjusted Sample size
Nima (Low income)	80,843	151	150
Osu (Middle income)	59,460	111	101
Airport Residential (High income)	5,079	10	21
Total	145,382	272	272

Source: Author's construct, 2018

This formula may be a very good guide to inform a researcher about the appropriate sampling size for individual study communities but may not necessarily fit in the Ghanaian communities. This is because it was developed in the advanced world where communities are stratified and well-planned. The opposite, therefore, happens in Ghana. It will be erroneous to completely adapt it for this study.

Therefore an adjustment was made to the calculated sample size of each community to arrive at a balanced output for the study to make valid inferences about the population (Robinson, 2006). In the final analysis, the sample for Osu was 101, that of Nima was 150 and Airport residential was 21.

A multi-stage sampling technique was employed for the quantitative survey. The multi-staged sampling involves a process whereby the sample is selected and sub-selected in stages normally from the sample frame (UNODC, 2010). The first stage of the multi-stage sampling was a purposive sampling of neighbourhoods based on the official residential classification that classifies them under low, middle and high-income residential areas (Songsore et al., 2009). The purpose of selecting these three different residential neighbourhoods was to have a varied perspective of respondents' attitude and perception towards mobile phone recycling depending on where they reside.

At the second stage, a systematic sampling technique was used to select respondents from the respective communities. The number of houses at Airport residential area was 533, Nima was 4,272 and Osu was 4,653 (GSS, 2014). Using the number of houses for Airport Residential area and sample size calculated (21), the systematic sampling interval was $25(533/21=25.3)$. It means that every 25th house in Airport Residential area was selected. The number of houses at Nima was 4,272, and the calculated sample size was 150, so the systematic sampling interval was 28 ($4,272/150=28$). Every 28th house was selected at Nima.

The number of houses at Osu was 4,653, and the calculated sample size was 101, so the systematic sampling interval also was 46 ($4,653/101$). Every 46th house was selected at Osu. The use of intervals helps researchers to possibly cover all parts of the study area (Neuman, 2014). After getting the sample interval for the various communities, a house at one edge of the residential area was randomly selected and using the calculated sample interval, houses that fall within the interval were sampled. Household heads were then sampled from each of the houses that were systematically sampled. The questionnaire was then administered to the household head. In situations where there were more than one households in the house, random sampling was further used to sample the household.

3.8.2 Qualitative Survey

Qualitative techniques such as in- depth interviews and observations were useful in analysing interest of various actors, their mutual dependencies, their networks and power relations. They also help to understand the lived experiences, complexities, negotiations, perceptions, conflicts and shared meanings of actors' everyday social worlds and realities (Limb & Dwyer, 2001). For instance, through a combination of in-depth interviews and direct observations, it was possible to understand the risks associated with the informal recycling of mobile phones.

3.8.2.1 In-depth Interview

Interviews were used for collection of data from various categories of respondents. First, in-depth interviews were held with a number of key informants. A key informant is a person who is considered to have some depth of knowledge concerning the research problem and who is willing to talk (Broshenka & Castro, 1983 in Teye, 2008). In-depth interviews were conducted for key informants at the Environmental Protection Agency, mobile phone repairers, dismantlers of non-functioning phones, and buyers of used phones and recycling companies.

Since the key informants had different backgrounds, different interview guide were used for each group. The interview guides just contained list of relevant topics to be discussed. So each in-depth interview was just a form of conversation or discussion around various topics. Many research textbooks recommend continuing to collect qualitative data, such as conducting additional interviews ,until data saturation is reached: in other words until the additional data collected provides few, if any new insights (Sanders,2009).

However, this does not show the number of respondents you may need for your sample (Sanders, 2009). Guest et al. (2006) recommends that for a research where the aim is to understand commonalities within a fairly homogeneous group, 12 in-depth interviews should suffice. However, in a heterogeneous population or where the research is wide ranging, Creswell (2007) recommends that between 25 to 30 interviews is appropriate.

The study, however, focused on twenty five stakeholders for the interview. Three key informants from the recycling companies, one Environmental Protection Agency Officer, two former RLG officers, ten mobile phone repairers, eight mobile phone collectors and one used phone seller were selected for the interview

Purposive sampling was used to select the stakeholders and key informants for the in-depth interviews. Purposive sampling is mostly used if the researcher is aware of people with the requisite information of the subject being studied. One disadvantage of this method is that the researcher can be biased in the selection of the respondents when purposive sampling is used. Even though there were disadvantages of this sampling technique, it was the best method to get the relevant information from the key informants. Studies have shown that interviews are primarily for meaning and processing, so they do not necessarily require large sample sizes. Table 3.2 presents a breakdown of the total number of interviews conducted.

Table 3. 2: Stakeholders and Number of Interviews Conducted

Stakeholders	Number Interviewed
Environmental Protection Agency (EPA)	1
RLG	2
Blancomet Recycling Company	1
Atlantic Holdings Recycling Company	2
Mobile phone repairers	10
Collectors of used mobile phone	8
Used phone seller	1
Total	25

Source: Author's construct

3.8.2.2 Observations

First-hand information was gathered through critical field observation which was used to complement data collected with other employed methods in the research. An observation involves the systematic noting and recording of events, behaviour and artefacts in a social setting (Teye, 2008). Acute attention and observation was given to the recycling process at

Agbogbloshie. The approach was mainly employed at mobile phone recycling sites and mobile phone repair shops. This allowed the researcher to understand various activities, including the daily activities of the mobile phone recyclers and the repairers, and the risks they encounter in their daily activities. Observation went hand in hand with informal individual interviews to aid in the analysis of study.

The type of observation employed conforms more to the "non-participant type", in which the observer remains relatively separate from his study population's activities (Broshenka & Castro, 1983 in Teye, 2008). The participant type, in which a researcher tries to become a member of the observee's social world, was not employed, given the fact that the issues to be observed were relatively open and could therefore be seen. Further, though the participant type helps the researcher to develop more trust with the group under study, a longer period of time would have been needed for this to be applied (Dowler, 2001).

The method also helped him to understand some of the issues that came up in the interviews and questionnaire surveys. For instance, the risks that informal mobile phone recyclers encounters was well understood. This is in line with the assertion of Broshenka and Castro (1983) cited in Teye (2008) that observation is the foundation of data collection because even when interviews are used, observing actions directly helps to better explain the feelings of respondents. Observational checklist was used to record some of the activities of the informal mobile phone recyclers and repairers at Agbogbloshie.

3.9 Data analysis technique

The data were edited to make sure they were correct and had no errors in them. The completed questionnaires were coded and entered into the computer using the Statistical Products and Services Solutions (SPSS version 23). The units of analysis were households.

Categorical data such as religion, education, marital status and age were analysed with tables and percentages.

Objective one and two were analysed using descriptive statistics such as cross-tabulation. Qualitatively, information from interviews was used to support it. Cross -tabulation was also used to analyse objective three. Interviews from key informants and stakeholders were also used.

However, the qualitative data were transcribed from the audio version, coded, categorised and analysed according to the themes through verbatim quotes of respondents relative to the research objectives as used by various studies (Burnard et al., 2008; Colorafi & Evans, 2016; Gyimah, 2017). Geographic information software Arc GIS 10.4 was used to produce the map of the study area. Chi square test was used to analyse the significant association between household size and the decision to recycle mobile phone. The chi square test was also used to test the relationship that exist between marital status and the decision to recycle mobile phone. A p-value of < 0.05 was considered statistically significant.

3.10 Reliability and Validity

3.10.1 Reliability

Reliability relates to the consistency of the data collected (Wallen and Fraenkel, 2013). Pre-test of the research instruments was carried out at East Legon to eliminate vague, leading and ambiguous questions. It was done to ensure that high-quality data collection instruments were used during the fieldwork period.

3.10.2 Validity

Validity is the degree to which an instrument measures what it intends to measure. An instrument is valid if it measures what it intends to measure and accurately achieves the purpose for which it was designed (Patten, 2004; Wallen & Fraenkel, 2013). Patten (2004) identifies three principles to improve content validity:

- I. Use a broad sample of content rather than a narrow one,
- II. Emphasise relevant material, and
- III. Write questions to measure the appropriate skill. The instruments were given to my supervisors to vet before field operation.

3.11 Summary

In this chapter, the study area and the research methodology were presented. The study area included the background of the study, economy, and population dynamics of the study area and ownership of mobile phone. The research methodology encompasses the research paradigm, sources of data, research design, target population, questionnaire for the quantitative data, observation and in-depth interview for the qualitative data, data analysis technique, reliability and validity of the study.

CHAPTER FOUR

ATTITUDES AND PERCEPTIONS TOWARDS MOBILE PHONE RECYCLING, REUSE AND THE REGULATORY REGIME

4.1 Introduction

This chapter presents the respondents' perceptions and attitudes toward mobile phone recycling, reuse and the regulatory regime. Among issues discussed in the chapter include considerations for opting for mobile phone recycling, perception of who should be responsible for recycling and financial contribution towards recycling. The second objective was presented using summary tables of respondents' opinion gathered from the survey and also data from in-depth interviews conducted with key stakeholders.

4.2 Demographic characteristics of respondents

4.2.1 Sex of respondents

Table 4.1 presents the results of the sex distribution of respondents from the three communities. From Table 4.1, 59 per cent of the respondents were males, while 41 per cent were females. The distribution of respondents in the study is different from the metropolitan level statistics, which shows that males are 48.1 per cent while females are 51.9 per cent. Similar differentiation is observed for the regional level statistics, which also shows that males are 48.3 per cent, while females are 51.6 per cent (GSS, 2014). The dominance of males in the study is also attributed to the methodological approach which focused on household heads. In this regard, males were likely to have more representation since male-dominated households are still the dominant feature in Ghanaian societies, even in the case of urban communities.

Table 4.1: Sex of respondents

Gender of respondents	Osu	Nima	Airport	Total
Male	49 (49.5)	95 (65.1)	12 (57.1)	156 (58.6)
Female	50 (50.50)	51 (34.9)	9 (42.9)	110 (41.4)
Total	99 (100.0)	146 (100.0)	21 (100.0)	266 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork 2018

4.2.2 Age of respondents

The next demographic variable that was discussed was the age of respondents. From Table 4.2, out of the total respondents of 268, 40 per cent were within the age bracket of 18-25 years. A total of 35 per cent of the respondents were within the age bracket of 26-35 years, while those in the age bracket of 36-45 years were 17 per cent of the total valid response. Those in the 46 and above year bracket constituted just 8 per cent of the sample.

An overall observation that can be made from this result is that the sample has a large representation of people within the youthful age, i.e. 18-35. Again, if the researcher was even to add those within the 36-45 age bracket, then we can conclude that this sample is within the active population group. The age distribution shows that the respondents were in a position to make decisions about their mobile phones, whether it should be given out for recycling or not.

Table 4.2: Age of respondents

Age of respondents	Osu	Nima	Airport	Total
18-25	33 (33.0)	71 (48.3)	2 (9.5)	106 (39.6)
26-35	41 (41.0)	48 (32.7)	6 (28.5)	95 (35.4)
36-45	19 (19.0)	20 (13.6)	7 (33.3)	46 (17.2)
46 above	7 (7.0)	8 (5.4)	6 (28.5)	21 (7.8)
Total	100 (100.0)	147 (100.0)	21 (100.0)	268 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork 2018

4.2.3 Occupation of respondents

As can be observed in Table 4.3, the result indicates that those within the sales and service category had the largest share of representation which was 28 per cent. This was followed by those within the skilled manual group, which was 17 per cent of the total sample. Those within the professional/technical profession constituted 14 per cent of total respondents.

Interestingly, the proportion of respondents who were unemployed constituted 26 per cent of the total population. The percentage share of the unemployed shows that unemployment is a major challenge to the Ghanaian economy. For instance, the 2018 unemployment rate in Ghana stood at 6.7% (ILO, 2018). The percentage share of respondents in work categories such as agriculture, clerical and pensioners was very marginal as can be observed in Table 4.3. The large proportion of respondents in sales/service and skilled manual work shows the relevance of the informal economic sector to Ghana.

Table 4. 3: Occupation of respondents

Occupation of respondents	Osu	Nima	Airport	Total
Professional/Technical	17 (16.8)	15 (10.3)	5 (23.8)	37 (13.8)
Sales/Services	25 (24.8)	43 (29.5)	7 (33.3)	75 (27.9)
Skilled manual	10 (9.9)	31 (21.2)	3 (14.3)	45 (16.7)
Unskilled manual	6 (5.9)	6 (4.1)	0 (0.0)	12 (4.5)
Clerical	10 (9.9)	1 (0.7)	1 (4.8)	12 (4.5)
Unemployed	24 (23.8)	44 (30.1)	2 (9.5)	70 (26.0)
Agriculture	3 (3.0)	3 (2.1)	0 (0.0)	6 (2.2)
Pensioner	0 (0.0)	1 (0.7)	1 (4.8)	2 (0.7)
Others	5 (5.0)	1 (0.7)	2 (9.5)	8 (3.0)
No response	1 (1.0)	1 (0.7)	0 (0.0)	2 (0.7)
Total	101 (100.0)	146 (100.0)	21 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.2.4 Respondents' level of education

In terms of the level of education, Table 4.4 shows that 43 per cent of the respondents have had SHS/SSS education, followed by those who have had HND/Diploma education, which was 19.3 per cent of the total sample. Respondents with graduate-level education constituted 14.1 per cent of the total sample. A considerable number of the respondents representing 91.1% had some form of formal education (basic to tertiary) as against 24 respondents (8.9%) with no formal education.

Table 4. 4: Respondents' level of education

Level of education	Osu	Nima	Airport	Total
None	7 (6.9)	16 (10.9)	1 (4.8)	24 (8.9)
Primary	1 (0.4)	8 (5.4)	0 (0.0)	9 (3.3)
JSS/JHS/Middle Sch.	8 (7.9)	43 (29.3)	1 (4.8)	52 (9.3)
SSS/SHS/Voc./Tec.	51(50.5)	61 (41.5)	3 (14.3)	115 (42.8)
HND/Diploma	13 (12.9)	10 (6.8)	3 (14.3)	26 (19.3)
Graduate	21 (20.8)	7 (4.8)	10 (47.6)	38 (14.1)
No response	0 (0.0)	2 (1.4)	3 (14.3)	5 (1.9)
Total	101 (100.0)	147 (100.0)	21 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.2.5 Income of respondents

The distribution of income across the various study communities is shown in Table 4.5. Forty seven per cent of the respondents earned between GHC 1-500 while 24 percent earned between GHC 501-1000. Respondents who earn between GHC 1001-1500 was 16 per cent. Distribution of respondents in the various categories above GHC 1500 was less than 10 per cent (for each of the category the proportion was less than 10 per cent). There were substantial variations in income distribution across the study communities. From Table 4.5, 43 per cent of the respondents who earned above GHC 2,500 lived at airport residential area and 39.6 per cent of respondents who earned between GHC 1001-1500 lived in Osu.

Meanwhile, among those who earned between GHC 1-500, the least (4.8%) were in airport residential area, followed by Osu with 24.7 per cent and the majority (66.7%) from Nima. It confirms the differences in economic status in these communities. Nima continues to be

one of the poor income communities in Accra and has developed into a slum over the years (Owusu et al. 2008). Unemployment and underemployment is a structural problem in the area, and for those engaged in income-earning activities, income earned from most of these activities are low.

Table 4. 5: The average income of respondents

Average income (GHC)	Osu	Nima	Airport	Total
1-500	25(24.7)	98 (66.7)	1 (4.8)	124 (47.2)
501-1000	29 (28.7)	34 (23.1)	2 (9.5)	65 (24.1)
1001-1500	40 (39.6)	2 (1.4)	2 (9.5)	44 (16.3)
1501-2000	3 (2.97)	4 (2.7)	5 (23.8)	12 (4.5)
2001-2500	1 (0.99)	0 (0.0)	2 (9.5)	3 (1.1)
Above 2500	1 (0.99)	1 (0.7)	9 (42.9)	11 (4.0)
No response	2 (1.98)	8 (5.4)	0 (0.0)	10 (3.7)
Total	101 (100.0)	147 (100.0)	21 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.2.6 Marital status of respondents

The marital status across the three socioeconomic communities is presented in Table 4.6. The results indicate that at Osu, 46 per cent of respondents sampled in the area were single (never married). Those who were married were 40 per cent of the total number of respondents, while those cohabiting were 13 per cent of the total sample. Concerning Nima, the result shows that 62 per cent of the respondents sampled from the area were single (never married) while 27 per cent of the respondents were married. Those cohabiting were 9 per cent.

For airport residential area, the results in Table 4.6 shows that 62 per cent of the respondents were married while 29 per cent of the respondents were single (never married). The results in Nima could be explained by the predominance of the youthful population in the community. Secondly, since marriage goes with raising a family, the financial situation of some youth may not also place them in an excellent position to take up the responsibility of raising a family. Concerning Airport residential, it can be argued that respondents are well established as this can be observed in their level of income in Table 4.5.

Table 4. 6: Marital status of respondents

Marital status	Osu	Nima	Airport	Total
Single	46 (45.5)	91 (62.3)	6 (28.6)	143 (53.4)
Cohabitation	13 (12.9)	13 (8.9)	0 (0.0)	26 (9.7)
Married	40 (39.6)	40 (27.4)	13 (61.9)	93 (34.7)
Divorced	0 (0.0)	0 (0.0)	2 (9.5)	2 (0.7)
Separated	1 (1.0)	0(0.0)	0 (0.0)	1 (0.4)
Widowed	1 (1.0)	2 (1.4)	0 (0.0)	3 (1.1)
Total	101 (100.0)	146 (100.0)	21 (100.0)	268 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.2.7 Relationship between marital status and decision to recycle mobile phone

This section seeks to determine whether or not one’s marital status has an impact on his /her willingness to recycle mobile phone. The responses were analysed based on the marital status of the respondents. From Table 4.7 most of the respondents (91.9%) were willing to recycle their mobile phone. Out of this number, 97.9 per cent of those who were willing to recycle their mobile phones were the married while 89.5 percent were single. The

percentage share of respondents who were divorced and separated was very marginal. Very few respondents (7.0) were not willing to recycle their mobile phones.

Table 4.7 Marital status and decision to recycle mobile phone

Decision to recycle	Single	Cohabitation	Married	Divorced	Separated	widowed	Total
Yes	128 (89.5)	23 (85.2)	92 (97.9)	2 (100.0)	1 (100.0)	2 (66.7)	248 (91.9)
No	12 (8.4)	4 (14.8)	2 (2.1)	0 (0.0)	0 (100.0)	1 (33.3)	19 (7.0)
No response	3 (2.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (100.0)	0 (0.0)	3 (1.1)
Total	143 (100.0)	27 (100.0)	94 (100.0)	2 (100.0)	1 (100.0)	3 (100.0)	270 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

Pearson Chi-Square

Number of Valid cases	270
Chi-square value	12.553
Degree of freedom	10
Significance (P value)	0.250

A chi-square test was conducted to ascertain whether one's marital status has a relationship with his/ her willingness to recycle mobile phones. Since the P value (0.250) is higher than the significant value of 0.05, there is no relationship between ones marital status and his/her willingness to recycle mobile phone.

4.2.8 Household size of respondents

Sixty four per cent of the respondents indicated that they have a household size of 1-5, while 16 per cent indicated that they have a household size of 6-10 (See Table 4.8). Again, 15 per cent of the respondents did not respond to this question. The result shows that a larger share of respondents in the various neighbourhoods had a household size of 1-5. The results thus show that household size in the communities are not large and corroborates with views

on the fact that urban families are mostly small in size (Sahleyesus et al., 2009). The results are also in synch with official records of the Metropolis (GSS, 2014).

Table 4.8: Distribution of respondents by household size

Household size	Osu	Nima	Airport	Total
1-5	75 (74.3)	81 (55.9)	16 (76.1)	172 (64.4)
6-10	12 (11.9)	28 (19.3)	3 (14.2)	43 (16.1)
11 and above	1 (1.0)	11 (7.6)	1 (4.8)	13 (4.9)
No response	13 (12.9)	25 (17.2)	1 (4.8)	39 (14.6)
Total	101 (100.0)	145 (100.0)	21 (100.0)	267 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.2.9 Relationship between household size and decision to recycle mobile phone

This part seeks to establish whether the size of one's household can influence the decision to recycle mobile phone. Most of the respondents (91.8%) were willing to recycle their mobile phones (See Table 4.9). Out of this number, most of the respondents (92.1%) who were willing to recycle their mobile phones were respondents with household size of 1-5 while 85 per cent were those with household size of 6-11. Very few respondents (7.1) were not willing to recycle their mobile phones.

Table 4.9 Household size and the decision to recycle mobile phone

Decision to recycle mobile phone	1-5	6-10	11 +	No response	Total
Yes	163 (92.1)	34 (85.0)	13 (100.0)	37 (94.9)	247 (91.8)
No	12 (6.8)	6 (15.0)	0 (0.0)	1 (2.6)	19 (7.1)
No response	2 (1.1)	0 (0.0)	0 (0.0)	1 (2.6)	3 (1.1)
Total	177 (100.0)	40 (100.0)	13 (100.0)	39 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

Pearson Chi-Square

Number of Valid cases	269
Chi-square value	7.287
Degree of freedom	6
Significance (P value)	0.295

A chi-square test was conducted to establish whether household size has a relationship with one's decision to recycle his or her mobile phone. Because the P value (0.295) is higher than the significant value of 0.05, there is no relationship between one's household size and his/her willingness to recycle mobile phone.

4.3 Experience with mobile phone usage

Before analysing respondent' perceptions and attitudes towards mobile phone recycling , reuse and the regulatory regime, the researcher first of all examined respondents experience with mobile phone usage. By so doing the researcher sort information from the respondents concerning the year they owned mobile phone, the number of times their phones have been changed, the average lifespan of their cell phone, disposal of their used phone and ascertain whether they are aware that used mobile phone contains precious metals.

Between 1992 and 1997, 4 per cent of the total respondents (270) used their first mobile phone as can be observed in Table 4.10. The few numbers of mobile phone used during this period may be ascribed to the fact that the first mobile phone call was made in Ghana in March 1992 (Dowuona, 2014). Airport residential area having the highest percentage share may also be attributed to the fact that, the community is for the affluent, so probably at that time, they were in a position to at least afford a phone. Again, because of their high-income status, they were in the position to be the first to use innovations and technologies.

Again, from 1998 to 2003, 17 per cent of the respondents used their first mobile phone. A similar distribution is found for the various neighbourhoods albeit with slight variations as shown in the case of Airport residential area. The percentage share for Osu was 16 per cent, 15.6 per cent for Nima and 33 per cent for Airport residential area. Most of the respondents used their first phone in 2004 and beyond. The percentage share for the period was 78 per cent. The result is not surprising because this was the period Ghana experienced an influx of the telecommunication industry (Dwowna, 2014). The teledensity (in respect of mobile phone alone) at that time grew from about 5 phones to 100 people in 2000 to 49 phones in 2008, an increase of about 190% (Oteng-Ababio, 2012b).

Table 4.10: First mobile phone

First mobile phone	Osu	Nima	Airport	Total
1992-1997	3 (3.0)	4 (2.7)	3 (14.3)	10 (3.7)
1998-2003	16 (15.8)	23 (15.6)	7 (33.3)	47 (17.4)
2004 and above	82 (81.2)	117 (79.6)	11 (52.4)	210 (77.8)
Total	101 (100.0)	147 (100.0)	21 (100.0)	270 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.4 First Mobile Phone

A summary of the first mobile phone used across the three socioeconomic communities is presented in Table 4.11. Out of the total respondents of 270, 15 per cent of the respondent's first mobile phone was Samsung. A total of 39 per cent of the respondents reported that their first mobile phone was Nokia while 11 per cent of the respondent's first phone was HTC.

Interestingly, 19 per cent of the respondents' first mobile phone was an iPhone. In the course of the data collection, the researcher realised that iPhone was a common phone at Nima even though it is a bit expensive. The researcher had an informal discussion with some of the respondents of the survey, and the aim of the discussion was to find out why iPhone was common at Nima.

The respondent revealed that although iPhone is expensive:

Most of the boys used it because if you use it for scam it cannot be tracked and the iPhone is a 'class' phone in the sense that it has certain features that the android phones don't have. For instance, the iPhone cannot be attacked by a virus and also it can easily be tracked when missing if only the person has an iCloud (A personal interview with a resident at Nima 43 years, April 12, 2018).

The second-hand market, which is fuelled by buyback and exchange of phones from 'pickpocketing' may also be a contributory factor for the many iPhones in Nima. Imitations from Dubai, Brazil, China, and other countries may also be another factor. It also resonates with an important aspect of the Theory of Planned Behaviour (TPB), which argues that intention for the use of an object results in the behaviour that comes along with its usage (Ajzen, 1991). The percentage share of respondents' first phone for Infinix, Tecno, Motorola, and others was very marginal as can be observed from Table 4.11.

Table 4.11: Type of first phone

Type of phone	Osu	Nima	Airport	Total
Samsung	18 (17.8)	19 (12.9)	4 (19.0)	41 (15.2)
Infinix	7 (6.9)	10 (6.8)	0 (0.0)	17 (6.3)
Nokia	32 (31.7)	68 (46.3)	4 (19.0)	104 (38.5)
Tecno	12 (11.9)	10 (6.8)	1 (4.8)	23 (8.5)
HTC	16 (15.8)	8 (5.4)	5 (23.8)	29 (10.7)
IPhone	16 (15.8)	30 (20.4)	5 (23.8)	52 (19.3)
Motorolla	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.4)
Others	0 (0.0)	1 (0.7)	2 (9.5)	3 (1.1)
Total	101 (100.0)	147 (100.0)	21 (100.0)	270 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.5 Mobile Phone replacement over the past five years

An overview of the number of times respondents have ever changed their phones over the past five years is presented in Table 4.12. Only 6 per cent have changed their phone once. It may be attributed to the fact that a mobile phone has a relatively short life cycle and (perceived) built obsolesce (Wen-jing Deng, 2017). It is possible that very few of the respondents have changed their phone once over the past five years because of the invention of new phones with new and improved models. Again, 13 per cent of the respondents have also changed their mobile phone twice over the past five years while 78 per cent of the respondents have also changed their mobile phone more than twice over the period. The question then is, why are people changing their phones frequently? In the course of the data

collection, the researcher had an informal discussion with some of the respondents, and the aim was to find out why they change their phones.

The respondent revealed that:

I change my phone so that I can get an upgrade from the manufacturer. When there is a new phone with longer battery life and large random access memory (RAM), I try to change my phone. You know using one phone for a long time makes you 'outdated person.' (A personal interview with resident at Osu 25 years, April 15, 2018)

Because most of the respondents of the survey have changed their phones more than twice, it can pose a threat to the environment if these phones were not disposed off properly. The frequency in the change of mobile phones without recourse to a system that can sustainably recycle mobile phone products means that more resources have to be mined to manufacture new phones. It will lead to the depletion of the limited natural resources. It may also compromise sustainable development Goal 12 (responsible consumption and production).

Table 4.12: Mobile phone replacement over the past five years

Number times phone have been replaced	Osu	Nima	Airport	Total
Once	7 (6.9)	10 (6.8)	0 (0.0)	17 (6.3)
Twice	19 (18.8)	13 (8.8)	4 (19.0)	36 (13.3)
More than twice	71 (70.3)	121 (82.3)	17 (81.0)	210 (77.8)
No response	4 (4.0)	3 (2.0)	0 (0.0)	7 (2.6)
Total	101 (100.0)	147 (100.0)	21 (100.0)	270 (100.0)

Numbers in brackets are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.6 Perceptions and attitudes towards mobile phones recycling

An effective means of taking back end-of-use mobile phones from consumers and taking it through the recycling process will be critical to any sustainable system of mobile phone recycling. Consumers are, therefore, key in this regard. However, it is important to understand in the first place respondents' attitudes and perceptions towards mobile phone recycling, as it will go a long way to inform policymakers of the appropriate policies that can induce consumers to give back their used mobile phones for recycling. The following results provide insight into some of the attitudes and perceptions of respondents towards mobile phone recycling.

The disposal options of respondents' used mobile phones are summarised in Table 4.13. More than half of the respondents (56 per cent) in the survey stockpile/keep their used phones, which concurs with some research in China and other countries (Ongondo and Williams, 2011a; Gao and XU, 2011). A total of 29 per cent of the respondents give their phone to someone as a form of disposal, two per cent sell to individuals or companies while five per cent trade to get a discount on a new phone. A small portion of the used phones are disposed of (5%) in the general waste. Although the amount that is disposed in the general waste is relatively small, it can still pose risks to human health and the environment. From the results and juxtaposing it with the TPB, one can say that the decision to keep obsolete mobile phones or give it to a friend can be examined from the perspective of attitude which is an important determinant of intention.

Here, it can be argued that the personal motivation to give out used mobile phone to a recycling company or donate it for recycling may not be there because consumers do not get anything from giving out their obsolete mobile phones. Instead, people may prefer to give them out to a friend or an acquaintance where it might seem that you are doing a favour to a friend or a close relation who does not have a mobile phone. Thus the motivation to

give it out to someone may be judged favourably compared to giving it out to a recycling company.

Table 4.13: Respondents' mode of disposal of used mobile phone

Disposal of used mobile phone	Osu	Nima	Airport	Total
Don't dispose but I keep it	53 (52.5)	88 (60.3)	10 (47.6)	151 (56.1)
Donate for recycling	1 (1.0)	2 (1.4)	1 (4.8)	4 (1.5)
Sell to individual/company	1 (1.0)	5 (3.4)	0 (0.0)	6 (2.2)
Trade to get discount on a new phone	3 (3.0)	8 (5.5)	1 (4.8)	12 (4.5)
Send to an organisation for disposal	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.4)
Give it to someone	37 (36.6)	30 (20.5)	9 (42.9)	77 (28.6)
Throw it away in the general waste	5 (5.0)	8 (5.5)	0 (0.0)	13 (4.8)
Others	1 (1.0)	0 (0.0)	0 (0.0)	1 (0.4)
No response	0 (1.0)	4 (2.7)	0 (0.0)	4 (1.5)
Total	101 (100.0)	146 (100.00)	21 (100.0)	269 (100.0)

Numbers in brackets are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.7 Decision to recycle

Respondents' opinion about whether or not mobile phones should be recycled is presented in Table 4.14. The responses were analysed based on the location or study communities. This was important as it sought to understand the similarities and differences in responses based on the communities. On the grounds of the survey, it seems that awareness on the importance of mobile phone recycling is relatively high among all the three study communities. Ninety three (93) per cent of the respondents indicated that mobile phones should be recycled while 7 per cent said it should not be recycled.

The result shows that an overwhelming proportion is in support of mobile phone recycling. Thus it can be observed that there is awareness on the need for some amount of recycling of end-of-use mobile phones in the system. This awareness is not contingent on where a person resides; neither does one's socio-economic status influences this perception or awareness. The results suggest that people have a positive view of the need for recycling.

Table 4.14: Should mobile phones be recycled?

Decision to recycle	Osu	Nima	Airport	Total
Yes	95 (94.1)	133 (92.4)	19 (95.0)	247 (93.2)
No	6 (5.9)	11 (7.6)	1 (5.0)	18 (6.8)
Total	101 (100.0)	144 (100.0)	20 (100.0)	265 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.8 Knowledge of recyclable materials in mobile phone

Respondents' knowledge of whether used mobile phone contain recyclable materials is summarised in Table 4.15. It can be observed that 36 per cent of the respondents reported that they were aware used mobile phone contain recyclable materials. A total of 64 per cent of the respondents said they were not aware that used mobile phone contains recyclable metals like gold, silver, or palladium. It may also account for why most respondents in Table 4.13 don't dispose of their used phones but rather keep them, for they are not aware of the precious metals contained in the used phone.

Table 4.15: Knowledge of recyclable materials in mobile phone

Knowledge of recyclable materials	Osu	Nima	Airport	Total
Yes	43 (42.6)	41 (27.9)	13 (61.9)	97 (35.9)
No	58 (57.4)	106 (72.1)	8 (38.1)	173 (64.1)
Total	101 (100.0)	147 (100.0)	21 (100.0)	270 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.9 Knowledge of toxic substances in mobile phone

Respondents' awareness of toxic substances contained in mobile phones is also presented below (See Table 4.16). Forty five per cent of the respondents reported that they were aware mobile phone contain elements which can hurt the well-being of people. A total of 55 per cent also indicated that they were not aware of the toxic substances that are found in mobile phones. Overall it can be suggested that even though the use of mobile phones have been on the increase and there have been growing accessibility over the years, knowledge about the potential harm that it can pose due to the chemical substances within it is still something that consumers have less knowledge.

Table 4.16: Knowledge of toxic substances contained in mobile phone

Knowledge of toxic substances in phones	Osu	Nima	Airport	Total
Yes	41 (40.6)	67 (46.5)	13 (61.9)	121 (45.3)
No	60 (59.4)	77 (53.5)	8 (38.1)	146 (54.7)
Total	101 (100.0)	144 (100.0)	21 (100.0)	267 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.10 Factors influencing mobile phone recycling

Factors that respondents considered when it comes to choosing a mobile phone recycler to give out their used phones for recycling is illustrated in Table 4.17. The results indicate that high recovery price or amount received for giving out the used phone was considered the most important. When observed for the total valid responses, i.e. 267, 44 per cent of the respondents said that high recovery price was the major factor they will consider. These findings are consistent with a study conducted by Nnorom et al., (2009b), and Wen-Jing Deng et al. (2017) that incentives are an integral part of any recycling scheme. Studies by Yla-Mella et al. (2015) and Yin et al. (2014b) corroborates the importance of incentives as an influence on consumers' attitude for giving out their phones for recycling.

The incentive will induce people to give out their phone for recycling. Further, this finding is in synch with the TPB in the sense that the decision to give out obsolete mobile phones for recycling is based on the self-interest and personal motivational factors. In this case, consumers are much concerned about the economic incentives that they will be getting from giving out their phones than any other reason.

The study supports prior studies on this topic which has shown that take-back of mobile phones for recycling purposes is an attitudinal issue which depends mostly on the advantages a consumer is likely to derive from the arrangement. Even though the mobile phone is not being used, consumers may feel that they are doing some favour to the state either by reducing environmental pollution or increasing the business prospect of another company and as such should be rewarded for their generosity

The ease with which recyclers can be contacted was 40 per cent of the total respondents (i.e. 267). The other factors include the proper approach to disposal and appropriate service time.

Another finding from this result was the fact that monetary incentive was not a major reason for respondents at Airport residential area compared to those in the other two neighbourhoods. The main reason that may be given to this result is that given the higher income earned by respondents at Airport residential area, getting money in return for their used mobile phone will not be a major issue for them, however, how it can be disposed will instead be a concern and that is why most of the respondents from Airport residential area (67 per cent) opined that ease of contact with a recycling firm would be an important option for them. Juxtaposing this with the TPB, it suggests that for those residing at Airport Residential Area, the motivation to give out their phones for recycling are more external and depends on the arrangement put in place by institutions.

Table 4.17: Factors influencing mobile phone recycling

Factors influencing mobile phone recycling	Osu	Nima	Airport	Total
Easy to contact	26 (26.3)	66 (44.9)	14 (66.7)	106 (39.7)
Proper approach to disposal	13 (13.1)	14 (9.4)	3 (14.3)	30 (11.2)
Appropriate service time	4 (4.0)	1 (0.7)	3 (14.3)	8 (3.0)
High recovery price	52 (52.5)	64 (43.5)	1 (4.8)	117 (43.8)
No response	4 (4.0)	2 (1.4)	0 (0.0)	6 (2.2)
Total	99 (100.0)	147 (100.0)	21 (100.0)	267 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.11 Perceptions on the right institution/Individual to be responsible for mobile phone recycling

Further, respondents were asked if they have an opinion about who should be at the forefront in mobile phone management and recycling. Overall, 71 per cent of the respondents held

the view that recycling of mobile phones and the process involved in the recovering of phones from consumers should be the work of manufacturers. From Table 4.18, 10 per cent of the respondents also indicated that it should be the government responsibility and 14 per cent were of the view that it should be a shared responsibility involving the manufacturer, government and other stakeholders including the public. A similar observation can be made with regard to responses for the three study communities. The responsibility for recycling and management of mobile phone waste is an issue that has engaged the attention of manufacturers in recent times. Because of this, some companies engaged in mobile phone production are coming out with innovative policies that seek to retrieve used and waste mobile phones from users and contribute to recent global efforts of sustainable development. One of such companies is Vodafone. Tanskanen (2012) reported on examples of Nokia coming out with policies to increase take backs from consumers in more than 40 countries. The issue of cooperation and engagement with key stakeholders is one of the best ways of managing mobile phone waste. This is because even though it is evident that manufacturers should bear most of the cost or all the responsibility, in practice, all stakeholders have important roles to play. This point suggests that behaviour on mobile phone recycling is a combination of attitude and subjective norm. The attitude, in this case, refers to the incentive for giving out a mobile phone for recycling and the subjective norm here refers to the arrangement put in place by other stakeholders to facilitate the ease of collection.

For instance, consumers' awareness and attitude towards recycling can influence the ease with which they give back their used mobile phones for recycling. From the perspective of government, they provide the regulatory environment, and the environment for business growth, especially businesses involved in the collection, disassembling and export of mobile phone parts to large corporations in the developed world. As indicated earlier, to

ensure efficient recycling of mobile phones, it should be the responsibility of all stakeholders.

Table 4.18: Institution/Individual responsible for mobile phone recycling

Institution/Individual responsible for mobile phone recycling	Osu	Nima	Airport	Total
Government	10 (9.9)	16 (10.9)	1 (4.8)	27 (10.0)
Manufacturer	72 (71.3)	106 (72.1)	14 (66.7)	192 (71.4)
Seller	1 (1.0)	1 (0.7)	0 (0.0)	2 (0.7)
Communication operator	3 (3.0)	5 (3.4)	0 (0.0)	8 (3.0)
Common responsibility	13 (12.9)	18 (12.2)	6 (28.6)	37 (13.8)
No response	2 (2.0)	1 (0.7)	0 (0.0)	3 (1.1)
Total	101 (100.0)	147 (100.0)	21 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.12 Financial contribution to mobile phone recycling

In addition to the important role that manufacturing companies are expected to play and the essence of incentives for consumers to give back more used mobile phones back into the recycling chain, is there also a need for consumers to also contribute to the recycling process since they also have a responsibility for ensuring that their lifestyle does not contribute to global waste and environmental problems? The results in Table 4.19 shows that 51 per cent indicated that they would be willing to contribute to the recycling of used mobile phones. The results corroborate a study by Nnorom et al. (2009b), where consumers were willing to contribute to the recycling of their used phone. A total of 48 per cent indicated that they would be unwilling to make any such payment.

Table 4.19: Payment for recycling

Financial contribution to the recycling of one's phone	Osu	Nima	Airport	Total
Yes	44 (44.4)	82 (55.8)	11 (51.3)	137 (51.3)
No	54 (54.5)	64 (43.5)	10 (47.6)	128 (47.9)
No response	1 (1.0)	1 (1.0)	0 (0.0)	2 (0.7)
Total	99 (100.0)	147 (100.0)	21 (100.0)	267 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.13 Percentage of total recycling cost one is willing to bear

If majority of the respondents are willing to contribute to the recycling of their phone, how much were they prepared to pay? Respondents view on how much they were ready to contribute to the overall cost of recycling of the mobile phone is illustrated in Table 4.20. Sixty eight per cent were willing to contribute up to 5 per cent of the overall recycling cost of their phones. This finding is in agreement with a study by Li et al. (2012) where more than half of the respondents were willing to pay less than 5% of the recycling cost of the retired mobile phone. A total of 10 per cent were willing to pay between 6-10 per cent of the cost. A total of seven per cent of the respondents were willing to contribute between 11-15%. A similar distribution is found for the three communities albeit with slight variations with the case of Airport Residential Area. The percentage share for Osu was 6.9 per cent, four per cent for Nima and 35 per cent for Airport Residential Area. Airport Residential having the highest percentage share may be ascribed to their high-income status.

Table 4.20: Percentage of total recycling cost one is willing to bear

Percentage of total recycling cost one is willing to bear	Osu	Nima	Airport	Total
0-5%	70 (69.0)	102 (71.8)	7 (35.0)	179 (68.0)
6-10%	10 (9.9)	11 (7.7)	5 (25.0)	26 (9.8)
11-15%	7 (6.9)	5 (3.5)	7 (35.0)	19 (7.2)
16-20%	3 (2.9)	2 (1.4)	1 (5.0)	6 (2.2)
21-25%	2 (1.9)	1 (0.70)	0 (0.0)	3 (1.1)
No response	9 (8.9)	21 (14.7)	0 (0.0)	30 (11.4)
Total	101 (100.0)	142 (100.0)	20 (100.0)	263 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2019

4.14 Respondents' attitude towards re-use of mobile phone

Mobile phone re-use is one of the ways of extending the product of the phone. If mobile phone reuse is encouraged, it will save the environment from pollution. Whether respondents would be willing to buy used phones or not is summarised in Table 4.21. Out of the total respondents of 269, 61 per cent said that they would not buy used phones while 39 per cent indicated that they would like to buy used phones. Many of the respondents not willing to buy used phones may be attributed to the challenges associated with used phones. One of the respondents that the researcher had an informal discussion with indicated that:

Some used phones are faulty, some of them are stolen phones and worse of all it doesn't have warranty. So you cannot guarantee the source of the used phone. Some of the sellers claim is from China but as a matter fact it is not always the case (A personal interview with resident at Airport Residential 34 years, April 19, 2018)

To facilitate reuse of mobile phones, consumers need to be committed to returning their phones to recovery centres. To enhance reuse of mobile phones, there is also a need for the establishment of a testing and refurbishing system to verify the quality of the phone.

Table 4.21: Respondents' attitude towards re-use of mobile phone

Would you like to buy a used phone	Osu	Nima	Airport	Total
Yes	36 (36.0)	60 (40.5)	9 (42.9)	105 (39.0)
No	64 (64.0)	87 (58.8)	12 (57.1)	163 (60.6)
No response	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.4)
Total	100 (100.0)	148 (100.0)	21 (100.0)	269 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2019

4.15 Prerequisites for buying used phones

Respondents who indicated that they would like to buy used phones (See Table 4.21) gave various reasons why they would like to buy a used phone. From Table 4.22, 38 per cent of the total respondents indicated that they would buy used phones if it has features that their current phone does not have. It corroborates a study by Sarath et al., (2015) which postulated that the rapid advancement in technology, which provides better models of mobile phones causes the consumer to change their phones more often. A total of 21 per cent also opined that they would buy a used phone if only they know the last owner.

Table 4.22: Prerequisites for buying used phones

Prerequisites for buying a used mobile phone	Osu	Nima	Airport	Total
Mobile phone is not more than one year	3 (8.1)	5 (8.2)	0 (0.0)	8 (7.5)
Has features my current phone does not have	15 (40.5)	22 (36.1)	4 (44.4)	41 (38.3)
If cheaper than a new phone	12 (32.4)	14 (23.0)	3 (33.3)	29 (27.1)
I know the last owner	6 (16.2)	15 (24.6)	1 (11.1)	22 (20.6)
Others	0 (0.0)	3 (4.9)	0 (0.0)	3 (2.8)
No response	1 (2.7)	2 (3.3)	1 (11.1)	4 (3.7)
Total	37 (100.0)	61 (100.0)	9 (100.0)	107(100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2019

Again, security is key when buying used phones because if you are not careful, you might buy a stolen phone. An informant at circle who sells used phones recounted that some of the challenges they face are that at times somebody can sell a stolen phone to you. It is not surprising some of the respondents of the survey want to buy used phones from somebody they know, this is because in case there is any security threat they can locate the person.

The informant recounted that there are a lot of advantages associated with used phones in the sense that some of the new phones are very expensive. He indicated that the price of used phones depend on the type of phone. It was highlighted by the informant in the quote below:

There are a lot of benefits associated with used phones because some people don't have the money to buy new phones in the sense that some phones like iPhones are very expensive, only a few people can afford it. As for the price of the used phone,

the type of phone will determine the price, you pay more for iPhone than Samsung (A personal interview with a used phone seller, 23 years at Circle, Accra May 12, 2018).

As much as there are benefits with used phones, there are some challenges with used phones. This is illustrated in the quote below:

There are some problems with used phones, when the person is selling it to you he will not tell you whether there is a problem or not and when you sell it to a customer it creates a lot of problems but we still sort the customers out in case there is a problem with the phone (A personal interview with a used phone seller 23 years at Circle, Accra, May 12, 2018).

The sellers of used phones also encounter some challenges from city authorities in their work. The informant explains it better:

At times those of us by the road side the 'abaaye' people sack us and the reason they give to us is that we should look for a shop but not all of us can get money to a rent a shop (A personal interview with a used phone seller 23 years at Circle, Accra May 12, 2018).

The life of these second-hand mobile phone sellers by the road side may also be at risk of contracting diseases from the exhausts fumes from the numerous vehicles that ply the road. They can also lose their lives should an accident occur where they sell their phones. To sustain the activities of these informal workers, it is expedient the government supports them. The government can also generate a lot of revenue from this sector. Going forward, the informant admonished that:

If the government can give us a place where we can sell our used phones and if every day we are paying some amount of tax like one cedi or something, the government can also use that money to pay those who clean the place (A personal interview with a used phone seller 25 years at Circle, Accra, May 12 2018).

4.16 Perceptions of how mobile phone waste can be managed and regulated

Ghana, like most developing countries, is beset with challenges when it comes to managing waste of all kinds. There have been various attempts since the introduction of the 1992 constitution to increase the country's capacity to address its waste problems both through the establishment of institutions, policy framework and regulations. The emergence of electronic and electrical waste has also brought to the fore the need to refocus policy direction to inculcate the management of e-waste in our waste management practices, especially due to the hazardous nature of e-waste.

This section of the chapter examined respondents' opinion on the best principle to regulate the recycling of mobile phone. The opinion of respondents and key stakeholders on the essence of the e-waste law in Ghana was also sought.

4.17 Best principle to guide people to recycle their phones

A summary of what respondents think is the best regulatory framework that will cause people to recycle their mobile phone across the three communities is presented in Table 4.23. Table 4.23 shows that 73 per cent of the respondents indicated that the best principle that will cause people to recycle their phone is law. This study corroborates research conducted by Miafodzyeval et al.; (2013) which established that most consumers participate in recycling because they want to avoid facing the consequences of the law. Further, this point also resonates with the perceived subjective norm as explained by the TPB which states that societal norms which may include legal and policy framework can influence people's intentions and invariably their behaviour (Ajzen, 1991; 2011).

Out of the total respondents of 269, 28 per cent also opined that norm is the best principle that will cause people to recycle their phone. Norms are the cultural products which represent an individual's basic knowledge of what others want to do and think that they

should do. Again, similar distribution is found for the various neighbourhoods albeit with slight variations as shown in the case of Airport residential area. At Osu, 21 per cent indicated that norm is the best principle while at Nima, 29 per cent opined that norm is the best principle. In the case of Airport residential area, 52 per cent indicated that norm is the best principle. The situation at Airport residential area corroborates a study by Ramayah et al. (2012) which affirms that norms have a significant influence on recycling behaviour. Further research can be conducted at the Airport residential area to ascertain why norm is the best regulatory framework that will cause people to recycle their used mobile phone.

Table 4. 23: Best regulatory framework that will cause people to recycle their phone

The best principle to guide people to recycle their phone	Osu	Nima	Airport	Total
Law	80 (79.2)	104 (71.2)	10 (47.6)	195 (72.5)
Norm	21 (20.8)	42 (28.8)	11 (52.4)	74 (27.5)
Total	101(100.0)	146(100.0)	21(100.0)	269(100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.18 Why law is the best principle for people to give out their phone for recycling?

Those who opined that law is the best principle that will cause people to recycle their phone gave the following reasons to support their point. Most of the respondents (93) per cent indicated that law is the best principle because it can be enforced. Three per cent of the respondents from Table 4.24 also opined that law is the best principle for people to recycle their phone in the sense that it is supreme hence binds everybody. As a society, we have not inculcated the culture of giving out phones and other electronic equipment for recycling. Without such a culture which might have been facilitated by education, there is the need to

use laws and other regulations to enforce these policies to change behavioural outcomes.

This will fit into the subjective norm perspective of the theory of Planned Behaviour.

Table 4.24: Why law is the best option for people to recycle their phones

Why law the best principle	Osu	Nima	Airport	Total
It can be enforced	74 (92.5)	97 (95.1)	11 (91.7)	182 (93.3)
Its supremacy binds everybody	1 (1.3)	3 (2.9)	1 (8.3)	6 (3.1)
No response	5 (6.3)	2 (2.0)	0 (0.0)	7 (3.6)
Total	80 (100.0)	102 (100.0)	12 (100.0)	195 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.19 Why norm is the best principle for people to give out their phone for recycling?

Again, answers were sought from respondents who opined that norm is the best option for people to recycle their phone. From Table 4.25, respondents who chose norm as the best principle that will cause people to recycle their phone also gave various reasons to support their point. Majority of the respondents (73 per cent) indicated that a norm is the best principle because people will willingly give their phones out for recycling. A total of 19 per cent of the respondents also opined that norm is the best option in the sense that norms are part of their culture hence people will not struggle to give out their used phone for recycling.

Table 4.25: Why norm is the best option for people to recycle their phones

Why norm is the best principle	Osu	Nima	Airport	Total
Is part of our culture so you don't struggle to do	2 (8.7)	12 (26.1)	1 (9.1)	15 (18.8)
People will willingly give their phones out	18 (78.3)	30 (65.2)	10 (90.9)	58 (72.5)
Is not by force	0 (0.0)	1 (2.2)	0 (0.0)	1 (1.3)
No response	3 (13.0)	3 (6.5)	0 (0.0)	6 (7.5)
Total	23(100.0)	46(100.0)	11(100.0)	80(100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.20 Why the need to regulate e-waste recycling in Ghana

Respondents' opinion on the need to have a law to regulate the recycling of e-waste in Ghana was also sought and the results is presented in Table 4.26. It can be observed from Table 4.26 that 47 per cent of the respondents indicated that having a law to regulate recycling will ensure compliance in the recycling industry. Out of the total respondents of 205, 28 per cent also opined that having a law as a regulatory framework will bring order in the industry while 17 per cent of the respondents also indicated that having a law as a regulatory framework will also reduce some of the bad practices associated with the crude recycling of e-waste.

Table 4.26: Why the need to have a law to regulate e-waste recycling in Ghana

Why the need to regulate e-waste recycling	Osu	Nima	Airport	Total
Compliance	46 (51.7)	45 (45.0)	6 (40.2)	97 (47.3)
It will bring order in the industry	18 (20.2)	38 (38.0)	2 (13.3)	58 (28.3)
Reduce bad practices of e-waste management	17 (19.1)	11 (11.0)	5 (33.3)	34 (16.6)
No response	8 (9.0)	6 (6.0)	2 (13.2)	16 (7.8)
Total	89(100.0)	100(100.0)	15(100.0)	205(100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

4.21 Awareness of the existence of e-waste law in Ghana

Again, Table 4.27 provides a summary of whether respondents are aware of the existence of any law that regulates the recycling of e-waste in Ghana. Majority of the respondents (91) per cent indicated that they were not aware of the existence of any law that regulates e-waste recycling in Ghana. Even though the Hazardous and Electronic Waste Control and Management Act was passed in 2016, most of the respondents were not aware of the existence of such law. It can be deduced from the above data that publicity is low concerning

the existence of such an important law. The percentage share of respondents who knew about such law is very marginal (9.3%) as can be observed from Table 4.27. The informant from EPA further revealed that currently, publicity on the existence of the law is low. He indicated that they have started training and educating people.

Table 4.27: Is there any law that regulates e-waste recycling in Ghana

Is there any law that regulates e-waste recycling in Ghana	Osu	Nima	Airport	Total
Yes	14 (14.3)	8 (5.8)	2 (10.0)	24 (9.3)
No	84 (85.7)	130 (94.2)	18 (90.0)	233 (90.7)
Total	98 (100.0)	138 (100.0)	20 (100.0)	257 (100.0)

Numbers in parentheses are percentages while those not in parentheses are the respondent counts

Source: Fieldwork, 2019

The researcher had further discussions with stakeholders who formulate and implement environmental policies and regulations. The interview sought to find out what they have been doing so far as managing electronic waste was concerned. In a discussion with the key informant from the EPA, it was revealed that the new Act and the current project being undertaken at Agbogbloshie would feature the informal sector since they are key in the collection of electronic and electrical waste. An interview with the informant at EPA at Accra provides much insight to the above point:

Throughout the law propagation, we have decided that nobody can be forcibly ejected from this business because we need to work in a way that in the next four to five years, you will either be absorbed by the system or you have nowhere to operate as an informal person. No informal person is going to be thrown out of the entire value chain, but you need to be able to find your niche where you can (A personal interview with a senior officer 56 Years at EPA, Accra April 19, 2018)

The informant further explained that the informal workers would be associated with groups and register. There will be collection centres in different parts of the city, and these centres will be the only place that electronic waste can be disposed of. Collectors will then be paid upon reception of the e-waste which will then be taken to the recycling facility at Agbogbloshie. As part of the project, all collectors will be given a card which will give them a unique identity, and it is also going to help monitor the activities of collectors since it will also have a tracking device in them. The informant from EPA explains it better:

Every person that is dealing with the collection of this will have to be registered and given our identity or else it will become impossible for you to go and sell. If you don't have an identity and you go and sell to the centre you might not get a buyer. And each person who is doing the collection must register with the centre. So we are designing applications which will allow them to make the connection. You see the tricycle that we have there, what we are doing is to try and put chips inside the tricycle such that each person who is collecting will have his chip connected to that particular tricycle. If you go and you take this, and you add, the chip will register the change in the weight, and there will be somebody who will be sitting down somewhere monitoring almost all these things. So if you are going to a house, you need to have an identity card, and that identity card must be linked to a centre and which we also have. We can track any of the identity cards to your geographic location, where you are at a particular moment. So if let's say there is a report somewhere on one of those people, once we can get the number we key into the system then it will tell us where the person is. (A personal interview with a senior officer 56 Years at EPA, Accra April 19, 2018,)

Again, looking at the effectiveness of EPA in regulating and monitoring the activities of e-waste in Ghana, the informant from EPA gave vivid explanations. The informant indicated that Blancomet recycling company initially used to take only the motherboard of the phone and dispose of the battery and the plastics. According to the informant, this attitude compelled EPA to close it until they accepted to pick the whole phone, take what they want

and dispose of the others in an environmentally friendly manner. It was highlighted by the informant at EPA:

A company (Blancomet) like the one I'm talking about in Belgium they used to buy only the motherboard, and we went inside to close them, so why will you want to take only the motherboard? What is left behind who handles it? You know we don't have the technology here to deal with it. So are you now saying that after taking what is useful we should still go and burn what we don't want that will still create the problems for us? It's completely unethical! (A personal interview with a senior officer 56 Years at EPA, Accra April 19, 2018,)

He indicated that because of EPA intervention, Blancomet now gives the mobile phone plastics to Duraplast to produce bio digester. He indicated further that the recyclers, exporters, and importers of e-waste are running after them. This is because:

It has reached a point that they are the people that are running after us. We have reached a point that they are running after us, not us running after them. Most of the people that we have licensed to recycle, all that I have to do is to wait for you at the port to find out what you are trying to export and we do backwards tracing. Until we give you the go ahead you cannot export. Together with the International Standards Organisation and the Materials Group, we have developed a conformity system from which we use to track goods that are exported and imported among countries (A personal interview with a senior officer 56 Years at EPA, Accra April 19, 2018)

In effect, before you can export or import any e-waste you need authorisation from both the receiving country and the country of origin, if not whatever you send out it will be rejected by the receiving country. This is because:

Minutes by minutes, the transactions that are going on we get, things that are turning towards my country I get to know, so you alert the people with a report. Even at a point in time, there was a programme that we use on a mobile phone it's called C-hog. Wherever the ship has reached you know, where the ship docks you know. As soon as it docks and it contains items that are this thing (questionable

items), you put a red card on it that it is a container that needs thorough inspection (A personal interview with a senior officer 56 Years at EPA, Accra, April 19, 2018)

The informant further indicated that they operate from a common platform, and that is what they use to control the import and export of e-waste. The informant explains it better:

The International Bureau of the Interpol of the various countries have a platform that we operate on. So that's how we do the control systems. Now and then I get messages from materials that are coming to our country. By our law, I Check and make sure that they are items that we want. So if you are trying to send something from my country to another country I will also leave that information out there (A personal interview with a senior officer 56 years at EPA, Accra April 19, 2018).

Recounting the effectiveness of policies and regulations, the e-waste recycling project is in its inchoate state as funding arrangement is still being worked on, and this information was given by the key informant from EPA. Even though the key informant from EPA indicated that the new Act would feature the informal sector, a critical review of the law shows that the new e-waste law will rather present new threats to the livelihood of the informal workers because it does not clarify their engagement as stakeholders in a sustainable e-waste economy.

There are some positives with the coming into the stream of this Act. First, it is the first to specifically tackle electronic waste, and domesticating provisions in the Basel Convention. Further, it proposes a self-financing model for managing e-waste in Ghana, especially with the payment of the levy for managing the waste products and the establishment of a recycling plant to help in the processing of e-waste. But going forward, the government should continuously engage with the informal sector since a breakdown in the consultation will render the project unworkable. After all, without a continuous supply of e-waste, the project will be a waste itself. Again, the government should be committed to and provide the necessary support for investment into the project from the private sector.

On the 28 of August 2018, the President of the Republic of Ghana, Nana Addo Dankwa Akufo-Addo graced the launching of the integrated e-waste recycling facility at Agbogbloshie⁶. The project which involves a treatment plant is part of the Hazardous and Electronic Waste Control and Management Act, Act 917 (2016). The project is expected to see the recycling of electrical and electronic waste in the country which is estimated to be 40 to 50 million tonnes annually. The project is not a stand-alone project but is integrated with other facets of the management of electronic waste which includes the collection of waste, transportation, etc. Overall it is expected to generate about 22,000 jobs for the youth including those in the formal and the informal sector.

4.22 Summary

The aim of this chapter was to assess respondents' attitudes and perceptions toward mobile phone recycling and reuse. The results showed that majority of the respondents believe that there is the need for mobile phones to be recycled. Further, respondents also indicated that among the factors they would consider in giving out their mobile phones for recycling will include high recovery price and ease of contact to the company that is interested in taking back mobile phones for recycling. About half of the respondents indicated that they would be willing to contribute financially for recycling, with 66 per cent indicating that they would contribute up to 5 per cent of the estimated cost of the phone.

The first objective was analysed through opinions shared by the respondents as well as interviews with key informants while the latter was also analysed through opinions shared by respondents and key stakeholders from EPA. For the perceptions of how mobile phone waste can be managed and regulated, it emerged that the best regulatory policy that will cause people to recycle their used phone is law. Critical to these regulations was how all

⁶<https://www.myjoyonline.com/news/2018/august-29th/govt-to-build-e-waste-recycling-facility-in-agbogbloshie.php>

stakeholders could be involved in the implementation of these laws while ensuring that specific provisions in the Act are adhered to. Before presenting results on the above objectives, the chapter presented the demographic background of respondents of the three study communities and their experience with mobile phone usage.

CHAPTER FIVE

PERCEPTIONS ON THE PROSPECTS AND PERCEIVED RISKS ASSOCIATED WITH MOBILE PHONE RECYCLING

5.1 Introduction

This section of the thesis presents results and discussion on perceptions of respondents on the prospects and the perceived risks associated with mobile phone recycling. With regard to the risks, the result is basically from perspectives shared by respondents and key informants during the interview sessions. Key issues that emerged are the environmental health risk, occupational risk, including hazards encountered by informal e-waste collectors and financial risks.

5.2 Mobile phone recycling: Respondents' perspectives

Individuals' perceptions of issues is crucial because it forms the basis for their behavioural pattern and practices. Recycling of mobile phones has become an important economic activity within the urban economy, for it provides economic opportunities for different people along the recycling chain. The economic opportunities associated with the mobile phone recycling circuitry can be vital for the sustainable management of natural resources critical to the mobile phone manufacturing industry.

5.2.1 Respondents' perceived prospects associated with mobile phone recycling

Mobile phone recycling provides a lot of economic opportunities for sustainable development. It can be viewed from two perspectives, i.e. environmental sustainability and economic development. In the course of the survey, respondents from the three communities were asked about the advantages mobile phone recycling offered. Table 5.1 shows the respondents' opinion on this question. It can be observed that about 64 per cent of the respondents indicated that mobile phone recycling would create job opportunities for

people. The results of this study corroborate studies by Ongondo and Williams (2011b) and Neira et al., (2006) which indicated that if a mobile phone is well managed, especially through recycling, it can generate employment opportunities both within the formal and the informal sector.

These findings are also in agreement with Oteng-Ababio (2012b) who indicated that informal recycling of e-waste is a source of livelihood for the urban poor. It can be argued that people take advantage of the proliferation of mobile phone waste to make meaningful livelihood to cater for their needs. In this case, you have people being mobile phone waste pickers, repairers, and those working in the recycling industries. Job opportunities arising from mobile phone recycling can be seen in both the formal and the informal sector. Job opportunities in the informal sector are critical and demand attention because this is where a lot of people, especially the youth, can be found.

Table 5.1: Perceived prospects of recycling mobile phones

Perceived prospects of mobile phone recycling	Osu	Nima	Airport	Total
Job creation and development	70 (69.3)	92 (62.2)	11 (52.4)	173 (64.1)
Revenue generation for government	10 (9.9)	9 (6.1)	2 (9.5)	21 (7.8)
Reduce environmental pollution	3 (3.0)	6 (4.1)	1 (4.8)	10 (3.7)
Sustain limited natural resources	1 (1.0)	11 (7.4)	0 (0.0)	12 (4.4)
Reduce price of mobile phone	5 (5.0)	20 (13.5)	0 (0.0)	25 (9.3)
Technology transfer	2 (2.0)	0 (0.0)	3 (14.3)	5 (1.9)
No response	10 (9.9)	10 (6.8)	4 (19.0)	24 (8.9)
Total	101 (100.0)	148 (100.0)	21 (100.0)	270 (100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2019

Within the mobile phone recycling chain, there are linkages between the formal and the informal sector, and it is this linkage that tends to sustain the jobs within the industry. In what follows next is the details regarding how people within the informal sector as well as the formal sector take advantage of the opportunities within the mobile phone recycling sector to create livelihoods.

The first activity was the role of collectors who form part of the value chain of mobile phone recycling. These are group of people who move within the urban space, both residential and commercial areas in search of discarded electronic and electrical parts, including mobile phones. Most of these collectors buy these discarded parts at a fee. One key informant at Agbogbloshie recounted that the price of one scrap phone is

‘One cedi but when we buy it from the customers it is 50 pesewas, but we sell it at one cedi’ (A man, 31 years, scrap mobile phone buyer at Agbogbloshie, April 10, 2018)

In the course of discussing with some repairers at Agbogbloshie, it was noticed that initially, they were given the discarded parts for free, but it was later the people understood the relevance of these discarded phones. It was also noticed that some of the activities of the collectors were on a small scale, and so after collecting these discarded phone parts, they send it to individuals engaged in the collection on a large scale. Some of them currently stationed at Agbogbloshie gather the motherboard and other valuable metal parts from the phone and then subsequently send to the large recycling plants stationed in Accra, Tema and North industrial area who also do further processing for export. To support the survey response, further insight was shared by stakeholders involved in mobile phone recycling.

There are other collectors who also send them to the factories right away without taking them to other intermediaries. The point is that this is a major source of livelihood for people, especially young people who find themselves in an urban economy that provides little

opportunities for them. It corroborates a study by Medina (2008) that one per cent of the world's population is supported through the collection and sale of recyclable waste where most of this happens in the informal sector.

In some cases, some of the collectors are pre-financed by these large processing companies. This point was highlighted by one of the study informants at Agbogbloshie and is indicated in the quote below:

In time past they could go out there and pick them for free. But now they have to pay for it. But because those who go round don't have money to go and pay, they have people who give them money, so there is pre-financing. So when you come back, the one who pre-finance you takes the scrap phones. They will weigh it. If it is equal to the amount, he gave you, game close. But if it is not equal, you will pay, or he will add it to the next day episode. The truth is that they make a lot of profit (Personal interview with a repairer at Agbogbloshie, April 12, 2018)

The informant further indicated that because the collectors have been going to the field for quite a long time, they have the expert knowledge when they see the items that you will term scrap, they understand the value of them. They will buy it as usual as they want. But they know the amount they will make out of it. There are times that they go and get more than the money they have, so they call back to whoever supported them for financial support. However, this depends on the long-established relationship with the collectors and the acute need of the raw material by the processing company. In recounting the critical role of collectors in the mobile phone recycling business, one of the managers at a processing factory at Atlantic Holdings, Osu interviewed indicated that:

'Informal collectors are important for our business. They go around mobile repairers to gather old phones that are spoiled. They bring them here, and we sort the various components. These include IC, motherboard, cases etc. Some can be reused, so we put it together and resell. We have some collectors who have been working with us for quite a long while, and I can say this job is sustaining them'

(Personal interview with a manager, 45 years at Atlantic Holdings, Osu, 25 April 2018).

The above discussion and the quote illustrate how people can take opportunities available to them to attain positive livelihood outcomes. It is evident from this study that people stand to improve their well-being and income because of the mobile phone recycling business. Further, there is also a reduction in the economically vulnerable situation as they become more independent and able to survive in the urban economy.

In the course of the data collection, I wanted to know whether mobile phone recycling was able to make life better for the informal recyclers compared to someone working in the public sector. The informant who is a first-degree holder from a technical university recounted that he is better off than someone working in the public sector. The point was highlighted by one of the study informants at Circle and is indicated in the quote below:

I am better for myself. I have friends in the navy and police who read the same program with me. They ask me to come and join or work in the public sector, but I told them I am okay. I want to work for myself. If you learn this work well, you will live well on it you can even build a house (Personal interview with Frenchman at Circle, 30 years, April 11, 2018)

As to how much the informal recyclers earn in a day was not disclosed by the informant. It may be attributed to the fact that people are not comfortable disclosing their income to people thinking that they will be taxed based on how much they earn. But looking at an informal mobile phone refurbisher not willing to work at the government sector where he will be taking more than the minimum wage at the end of the month tells you that the business is lucrative. The researcher further interrogated the informant the number of phones he can work with a day and how much he charges. The informant indicated that he could work on about five phones in a day and for the charge, he charges at least 30 Ghana cedis for a phone. So in effect, if he charges at least 30 Ghana cedis for a phone he will

make about 150 Ghana cedis in a day. The informant further indicated that during the peak season they get more phones, so they work extra. It can be deduced that the informal mobile phone recycling is indeed lucrative and sustaining.

Another area of employment opportunity is within the formal sector. The focus is on industrial processing plants that are used in, disassembling, dismantling, crushing and processing of electronic and mobile phone parts for onward export to other countries.

It was revealed by a key informant at Blancomet recycling company that

Currently, we do not have a recycling plant in Ghana that can recycle in the sense of changing the valuable parts of a mobile phone into an original form that can be used (Personal interview with senior officer 42 years at Blancomet Recycling Company, April 14, 2018)

The role of these recycling companies like Blancomet is critical in the sense that apart from taking waste from the system, they employ a lot of people with different categories of skills. But their activities are contingent on the role of collectors. In fact, in the course of the fieldwork, it was realised that the smooth operation of these processing factories depends on their relationship and constant supply of the products from collectors. Significantly, it was realised that these companies like Blancomet at North Industrial area have other openings in other West African countries, thus suggesting the business potential it has as it is able to expand. It is illustrated in the quote below

We have branches all over West Africa. We are located in Togo, Benin, Nigeria, Cote d'ivoire, and we are currently going to Sierra Leone. We are in Guinea. We collect from various countries and bring everything down here. Eventually, we put the stock and do our work (Personal interview with senior officer 42 years at Blancomet Recycling Company, April 14, 2018)

Mobile phone recycling has also opened avenues for training and skill transfer for people which also increases their employable skills. More critical, Atlantic Holdings at Osu help

in training young people in mobile phone repairs so that they can independently set up their own business. They also take prospective trainees through some form of quasi-formal education so that they can understand the usefulness of various components of mobile phone parts and why these resources need to be reused and brought back into the chain. One such organisation currently engaged in this knowledge and skill transfer is Atlantic Holdings. An interview with one senior official of Atlantic Holdings at Osu provide much insight to the above point:

That is our lecture hall. We do training programs for people, people in the e-waste business who want to get adequate knowledge on how to repair electronic equipment. For the mobile phones, we educate the people, and if you have a thing like that, you can bring it, and we pay you (A senior officer 38 years at Atlantic Holdings, April 17, 2018).

Further to the above, the fieldwork at Agbogbloshie revealed that the collection of dysfunctional mobile phones for recycling provides raw materials for industries. The continuous source of these materials (i.e. mobile phone and electronic parts) is what keeps major Assembly industries in business. That is why some industries like Blancomet at North industrial area invest heavily in this business by opening new branches of the business in different West African countries and also pre-financing collectors to go to all parts of the country or into other countries to get the materials which they later export after disassembling the various components. On the part of the big industries in Europe, the continual flow of these materials is quite important, especially in the wake of the depletion of natural resources such as gold. Thus investing in the recycling of electronic parts where materials can be extracted, recycling and reuse is not just the best alternative but also the most sustainable.

Respondents also opined that mobile phone recycling would contribute to government revenue sources, and this response was 8 per cent of the total proportion of responses. This

viewpoint is true, especially when there seems to be an increase in the number of industries engaged in the recycling of electronic products in most countries. In Ghana, we still do not have an industry involved in converting waste mobile phones into brand new products.

Most of the industries in Ghana are engaged in the export of the products to the leading manufacturing industries in Europe which include Germany and Lithuania and also to South American countries such as Bolivia, and this was revealed in the fieldwork during a conversation with a key informant at Blancomet recycling company at North Industrial Area in Accra. The main point here is that most of these industries pay taxes both to the central government and to city authorities for their operations. Government is also able to collect income tax from workers employed in the industries since these are formal job establishments.

Table 5.1 shows that 4 per cent of the respondents were of the opinion that mobile phone recycling limited the use and dependence on limited natural resources. The above point is consistent with an argument by Kumar et al. (2005), who argued that electronic waste recycling is a closed-loop system within an industrial ecosystem.

Recycling of mobile phones helps in reducing the amount of waste, especially electronic waste, in the environment. Table 5.1 shows that four per cent of respondents in the study expressed this opinion. The issue of pollution is a major problem in most urban areas, especially in developing countries where the institutional capacity of managing these electronic products is a major issue. Thus mobile phone take-back with the reason for recycling the products for use is considered the most cost-efficient means of reducing waste in the system. In Ghana, for instance, one of the emerging challenges that we seem to be confronted with is electronic waste, apart from the municipal solid waste which we are still yet to fully grapple with.

The increasing income and consumption pattern means that any attempt aimed at reducing electronic waste through recycling of unwanted electronic products such as mobile phone will be beneficial for the country since increased levels of this waste will prove challenging for the country to manage. It is within this context that the role of the informal sector which are mostly engaged in the collection process must be supported as well as the industries who provide direct job opportunities for these people.

Mobile phone recycling and re-use is one of the most sustainable means of managing electronic waste in any country and fits into the global sustainable development agenda. In particular, mobile phone recycling fits into the Sustainable Development Goal 11 and 12, which seeks to promote sustainable cities and communities and enhance responsible production and consumption. It will encourage healthy and sustainable cities because it will reduce the amount of waste generated in cities and reduce the current waste management crisis we are unable to grapple with as a country.

From Table 5.1, 4 per cent of the respondents also opined that mobile phones would sustain limited natural resources. This study corroborates a study by Umicore (2011) which indicates that mobile phone contains 13 ppm of copper, 3500 ppm of silver, 340 ppm of gold and, 130 ppm of palladium which when recycled can reduce pressure on the limited natural resources. Mobile phone recycling also reduces the reliance on the valuable natural resources whose availability are fixed and gradually depleting as the years go by. Thus, it reduces the extraction of these resources and ensures that the current resources already extracted continue to go through the value chain process.

5.2.2 Respondents' perceived risks of mobile phone recycling

Recycling of mobile phone can pose severe problems for central governments and local authorities if not well managed. Respondents were asked to give their opinions about the

challenges mobile phone recycling can pose in Metropolitan Accra. Table 5.2 provides a summary of some challenges that respondents think can be encountered in mobile phone recycling. Further, this section also reports on insights shared on some of these risks encountered by industries and other players within the mobile phone recycling sector.

From Table 5.2, 24 per cent indicated that mobile phone recycling might cause land pollution or challenges. The results corroborate a study by Silveira et al., (2010) which suggests that the metals from mobile phone batteries have the potential to leach slowly into the soil, groundwater, surface water and even the geological structure of the land. The results also corroborate with a similar study by Robinson (2009), which indicates that recycling of waste mobile phones causes land degradation in developing countries. Indeed, it is well noted that mobile phone recycling requires well-developed systems that ensure that every component of the mobile phone is well-handled and does not go back into the environment. It means that after the collection of valuable metals, there must be a way to dispose of other parts of the mobile phone, either to be used for other things or disposed-off well.

Table 5.2: Respondents' perceived risks of mobile phone recycling

Perceived risks in mobile phone recycling	Osu	Nima	Airport	Total
Land pollution	21 (20.79)	39 (26.3)	4 (19.0)	64 (23.7)
Battery of the phone can explode	18 (17.82)	26 (17.56)	2 (9.52)	46 (17.0)
Reduction in quality of recycled phone	3 (2.97)	10 (6.8)	0 (0.0)	13 (4.8)
Mobile phone theft will increase	1 (1.0)	12 (8.1)	0 (0.0)	13 (4.8)
Financial challenge	12 (11.9)	16 (10.8)	2 (9.5)	30 (11.1)
Reduction in average lifespan of phone	1 (1.0)	7 (4.7)	0 (0.0)	8 (3.0)
Leakage of personal information	4 (4.0)	2 (1.4)	0 (0.0)	6 (2.2)
Don't know	21 (20.8)	2 (1.4)	4 (19.0)	27 (10.7)
Others	2 (2.0)	0 (0.0)	1 (4.8)	3 (1.1)
No response	17 (16.8)	34 (23.0)	8 (38.1)	59 (21.9)
Total	101(100.0)	148(100.0)	21 (100.0)	270(100.0)

Numbers in parentheses are percentages while those not in brackets are the respondent counts

Source: Fieldwork, 2018

In Ghana, after collectors in the informal sector have dismantled or separated the various components of the phone, they usually gather the valuable parts that the industries need and dispose off the plastics and other parts straight into the environment or burn them. As indicated by Bereketli et al. (2009) and Lincoln et al. (2007) mobile phones contain hazardous substances such as arsenic, beryllium, cadmium, copper, lead, nickel, and zinc and it can pose an environmental health risk to people, especially people close to these substances. To address this challenge, Blancomet at North industrial area has advised

informal mobile phone collectors to bring the whole mobile phone so that they do the separation themselves.

It also calls for how, as a country, we are prepared to handle our electronic waste. Without proper management of these hazardous substances, it may compromise the sustainability of the environment, and the livelihood people are making from mobile phone waste recycling. Again, 17 per cent of the respondents also opined that another challenge that may be associated with mobile phone recycling is that the battery of the phone can explode. It corroborates a study by Velmurugan (2016) which indicates that recycling of mobile phone may pose some risk for human life because the battery can explode through the informal recycling of the phone.

Further, 11 per cent indicated that mobile phone recycling might also come with its financial challenges. All three communities see the financial challenge as an issue that mobile phone recycling companies may face. The concern of the respondents was about the infrastructure and institutional apparatus required to manage the recycling process. First of all, the private sector must see the business opportunity in this venture and invest in it. Without a developed financial system to provide capital for such investment, it will be difficult for local business to venture into this activity.

In most developing countries and as was observed in Ghana, industries like Blancomet recycling company, separate the important parts and export to foreign-based companies. Even though there are no companies involved in recycling of mobile phone as in the sense of converting parts into a brand new phone, the kind of separation that was done required sophisticated machines and technology which requires money to do that. Thus, in this period of government withdrawal from mainstream business, and also within a system that gives little support to local business entrepreneurs, it will be difficult for anybody to invest in this

activity unless there is a foreign investment into this activity. This issue also brings to the fore the role of institutions in creating the enabling environment that will foster job creation and help individuals to undertake a meaningful livelihood out of the opportunities available for them.

Other issues that respondents raised include the fact that recycling can reduce the quality of the mobile phone (5%). The results also corroborate a similar study by Geyer and Blass (2010) which indicates that there is a reduction in recycled handset mass of 66% and gold content of 60% from 1992 to 2004 and the gold content might even reduce further. The issue of reduction in quality may be right in some sense, especially when juxtaposed with the fact that most of the valuable components may not be in their original state. However, there has not been much research on this to base any firm conclusions on the issue. Thus more research is required in this area. A total of 5 per cent of the respondents indicated that mobile phone recycling would increase phone theft. Discussions with some buyers at Agbogbloshie revealed that without any regulations to control this activity, especially those in the informal sector in terms of finding out where exactly they get the phones and how they obtained these phones from, it might lead to increased mobile phone theft. Again, 2 per cent of the respondents indicated that recycling might lead to leakage of information. An interview with a key informant at formal RLG Ghana provide much insight to the above point:

The risk of the end-user having his or her information pass on is very critical. When you format your information, where does it go, you need a special skill to know where the information is. A mere consumer does not know where the formatted information goes but to an expert; the formatted information is converted into another format which can be read. When you give the motherboard of your phone for recycling information stored on the phone can be assessed by an expert'. (A senior officer, 49 years at Former RLG, April 19, 2018).

One of the respondents recounted a situation whereby a friend gave his phone out because it was no longer useful to him. Unfortunately, he did not delete all the information on the memory and later became a victim of a fraud incident. Thus, there is the likelihood of letting your personal information out if you are not careful.

Again, 11 per cent of the respondents indicated that they do not have any idea about this question. Again, further insight was also shared by stakeholders in the industrial sector. An interaction the researcher had with industries involved in separation and disassembling of mobile parts revealed that there was limited supply to match up with the demands of the industry. They attributed this to the undeveloped informal sector. The informant at Blancomet recycling company indicated that in most cases they had to deal with suppliers on an individual basis, with each bringing in a limited amount of goods.

Further, these industries compete among themselves for the limited number of supplies from the informal sector. The problem with the limited supply can also be adequately placed at the source centre where most people are not aware of the importance of take-backs and the need to return waste mobile phones to the recycling stream. This point was highlighted by one of the study informants and is indicated in the quote below:

You don't easily get spoilt and unused mobile phones. Phones don't easily spoil except the recent china phones. But it also depends on the price. Some repairers have them, but if the price is not good they will not give them to you. That is why we have expanded to other countries to gather them. There are agents who go round to gather them. We give them money, and they go round to gather them. There are certain components that are difficult to gather the stock. Example the phone boards. So we have to gather across West Africa, and then after gathering we extract them' (A man, 49 years, a worker at Blancomet recycling company at North Industrial area, April 12, 2018)

Another point highlighted by the key informant at Blancomet recycling company at the North Industrial area was the fluctuation in the market prices of used electronic and

electrical parts on the world market. It has to do with the demand and supply situation on the world market, and this situation normally influences returns from export for these industries. My interaction with the informant indicated that sometimes when prices come down at the world market level, they do not significantly reduce the price they buy from suppliers since doing that will serve as a disincentive for the suppliers and may end up losing them altogether. In some situations, they are left with no alternative than to maintain the price they give to their suppliers in order to stay afloat in the business. Suppliers sometimes respond by hoarding their goods waiting for times when the prices are good. This market situation significantly affects the profitability of the business and reduces incentives for investment in the sector. Other cost elements to the operations of these industries include the cost of utility and government taxes on their operations.

Further, some of the informants at Agbogbloshie indicated that there is a possibility of contracting diseases in the course of mobile phone recycling, especially in the process of dismantling and separating parts of the phone. A question was posed to one of the key informants at Agbogbloshie who manually dismantles the mobile phone to retrieve the precious metals as to whether they wear gloves or not, the response was yes, but my observation at their activities shows that they do not wear any gloves to protect themselves. There is, therefore, the possibility of them contracting infectious and skin related diseases in the course of their work. The informants were not able to tell exactly which chemicals were in the mobile phones and when being disassembled were poisonous to the health of those involved, but they did emphasize that there were toxic substances which were dangerous to the health of people especially people at Agbogbloshie who are normally engaged in these activities.

The quote below elaborates on this point:

'I don't know much about the business because I am not an expert. But on the surface, you can see that the way we go about our activity is very dangerous. The burning of electronic parts and the smoke coming out is very dangerous for our health. This is a serious risk factor for cancer and other respiratory diseases' (A man, 30 years, scrap mobile phone buyer at Agboghloshie, April 12, 2018

Important views were expressed by industry players in the recycling sector. In the course of the fieldwork, interviews with a representative from Blancomet recycling company at North industrial area in Accra engaged in separation of mobile phone component for export to manufacturing companies in the developed countries provided insight on some of the risk. The first point had to do with the activities of some of the informal e-waste collectors who normally bring unwanted and used mobile phones to them for the separation. It was revealed that in the course of transporting these materials, these collectors are at risk of being knocked down by vehicles. It was revealed in the course of the discussion that most of them used hand trolleys packed with motherboards and different metal components. There have been occasions he recounted some were knocked down by vehicles in the course of transporting these parts. The vehicular accident is not limited to when they are transporting it to the factory but also during their search, especially in the commercial areas of Accra. Since their activity was such vital to the functioning of the industry, the interviewee indicated that they have advised them to bring the assembled parts by vehicle; however, most have declined because of the cost of transportation.

Further, the health risk of some of the activities of the collectors came to the fore, it was revealed both from interviews with representatives of industries and observation on the field that a number of collectors who bring used mobile phones to recycling factories burn some parts of the phone like the plastics in an attempt to extract precious metals which are of essence to these industries. The reason for engaging in the burning is to reduce the volume

that they bring to the recycling plants because bringing the whole device which includes mobile phones and other electronic devices will be bulky and at the end of the day they may not be able to carry a large amount of these devices. Some are engaged in manual separation using obsolete tools which sometimes destroy some of the precious materials such as the motherboards.

The risk here is that in the course of burning the materials, they do not use protective gears and gloves. This exposes them to chemical substances such as lead, mercury, arsenic, chlorine, and bromine which are toxic substances found in phones with serious human health problems such as cancers, kidney problems, and skin infections. The burning of materials to retrieve the precious metals from the phone also increases their exposure to smoke and other toxic fumes hence increasing their level of vulnerability. The interview with Blancomet recycling company revealed that collectors are advised to bring the whole part since the industries have the equipment to do the separation. The plastics are given out to industries close by who need them so that waste can be reduced.

With regard to the industry or recycling factories, the interviewee indicated that they have their challenges which exposed their workers to various forms of risk. It was revealed that these industries which are engaged in separation have a number of machines and include those used in crashing the devices and those used in separation. Workers are likely to be injured if they don't handle or operate these machines well or safety precautions are not adhered to at the workplace. The interview indicated that workers are taken through thorough education and training on how to operate the machines to minimise workplace accidents. Further, it was revealed that there are periodic audits carried out by various government agencies such as EPA, Fire service and the environmental health section of the Accra Metropolitan Assembly all in an attempt to make sure that there is adherence to workplace safety standards.

To avoid passing your information to experts while recycling your phone the informant from former RLG indicated that, it is better to bury the phone than to give it out to recyclers.

He explains it better in the quote below:

‘ If you want to avoid somebody having access to your information after you have stopped using a device you either put it in a septic tank where it will be in contact with water and the various components will rust, there will be no direct contact with the device ,also if you bury it you are likely to have the same experience because there will be moisture in the soil hence rusting will take place but for the purposes of recycling you may want to perforate sensitive areas then you cannot reach anything’ (A man, 39 years worker at former RLG, April 15, 2018)

It is also not the best advice because some of the toxic substances can leach slowly into the ground. Going forward, there should be a law to ensure digital security of people who willingly give out their phone for recycling.

5.3 Summary

The chapter assessed respondents’ awareness of the prospects and the perceived risks of mobile phones recycling in Ghana. The findings revealed that among the prospects of mobile phone recycling include creation of job opportunities, revenue generation for the government, reduction in environmental pollution and price reduction of mobile phones.

Some risks associated with the mobile phone recycling industry are financial challenges as it will require a high injection of capital and which at present the economic situation in the country may not permit and the likelihood of mobile phone theft. Some of the risks were environmental health risk, occupational risk, including hazards encountered by informal e-waste collectors, and digital security.

CHAPTER SIX

SUMMARY OF MAJOR FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND AREAS FOR FURTHER STUDIES

6.1 Introduction

This chapter presents the results of the study, which includes a summary of the findings with respect to respondents' perceptions and attitudes towards mobile phone recycling and reuse. Respondents' awareness of how mobile phone waste can be managed and regulated, and respondents' perceived prospects and the risks associated with the industry was also presented. Generally, this section presents summary, conclusions, recommendations and areas for further studies.

6.2 Summary of Major Findings

6.2.1 Respondents' attitudes and perceptions towards mobile phone recycling and reuse

From the study, respondents gave various factors they will consider before giving out their phone for recycling. High recovery price was considered the most important factor. It, therefore, affirms the words of Solomon in the bible that 'money answereth all things'. Most of the respondents from the survey opined that recycling of mobile phone should be the responsibility of the manufacturer. About half of the respondents indicated that they would be willing to contribute financially for the recycling of their used mobile phone while 66 per cent indicated that they would contribute up to 5 per cent of the estimated cost of the phone. Most of the respondents were not aware of waste mobile phone contain recyclable materials. More than half of the respondents were also not aware of the toxic substances contained in the mobile phone. More than half of the respondents also opined that they will not buy used phone. Their reason was that there is no warranty for used phones and some

of the used phones are also stolen. More than a third of the respondents who indicated that they would like to buy a used phone said that they would buy a used phone if only it has features their current phone doesn't have.

6.2.2 Perceptions of how mobile phone waste should be managed and regulated

Ghana, like most developing countries, is beset with challenges when it comes to managing waste of all kinds. The emergence of electronic waste has brought to the fore the need to refocus policy direction to inculcate the management of electronic waste in our waste management practices, especially due to the hazardous nature of e-waste. Perception of respondents on how mobile phone waste can be managed and regulated were discussed.

Critical to these regulations was how all stakeholders could be involved in the implementation of these laws while ensuring that specific provisions are adhered to. It also emerged from the survey that the best regulatory policy that will cause people to recycle their phone was a law because it can be enforced.

Again, most of the respondents were not aware of the existence of the e-waste law. It also emerged that the new Act will feature the informal sector since they are key in the collection of electronic and electrical waste and that they will be associated into groups and register with EPA. EPA is also working seriously to ensure that all stakeholders who matter comply with the e-waste law. Recounting the effectiveness of the e-waste law, it is likely to present new threats to the livelihood of the informal workers because the law does not clarify their engagement as stakeholders in the e-waste economy.

6.2.3 Respondents' perceived prospects and risks associated with mobile phone recycling

Mobile phone recycling provides a lot of economic advantages for sustainable development. It can be viewed from two perspectives, i.e. environmental sustainability and economic

development. The findings from the survey suggest that one of the prospects of mobile phone recycling include creating job opportunities for people in both formal and the informal sector and within the mobile phone recycling chain, there are linkages that sustain the jobs within the sector.

The first group is the role of collectors. They are people who move within the urban space, both residential and commercial areas in search of discarded mobile phones. Initially, they were picking them for free, but when people understood the relevance of these discarded phones, they give it to them at a fee.

It was noticed that some of the activities of the collectors were on a small scale, and so after collecting these discarded phones, they send it to individuals engaged in the collection on a large scale. There are other collectors who also send them to the factories right away without taking them to other intermediaries. Some of the collectors are also sponsored by middlemen and even the recycling companies to get the scrap phones for them. However, this depends on the long-established relationship with the collectors and the acute need of the raw material by the recycling companies.

Mobile phone recycling was not just a means of survival for the unemployed, but it is a very lucrative enterprise. It was noticed that a graduate was not willing to leave the informal recycling of mobile phone for public sector job and indicated that he is better off than his colleagues who are in navy and the police service. Mobile phone recycling has also opened avenues for training and skills transfer for people in the informal sector which increases their employable skills. People take advantage of the proliferation of mobile waste to make meaningful livelihood to cater for their needs.

From the study, it was noticed that mobile phone recycling would contribute to government revenue because industries that are engaged in the disassembly and export of mobile phones

pay tax to the government. Again, mobile phone recycling will reduce our dependence on the limited natural resources in the sense that mineral resources will not be exploited to manufacture new mobile phones.

The issue of pollution is a major challenge in most urban areas, especially in developing countries where the institutional capacity of managing these electronic products is a major issue. From the survey, it emerged that mobile phone recycling would reduce the amount of electronic waste generated. Some of the respondents also opined that mobile phone recycling would reduce the price of mobile phones in the sense that new raw materials will not be mined to produce new phones. Mobile phone recycling fits into the Sustainable Development goal 11 and 12, which seeks to promote sustainable cities and communities and enhance responsible production and consumption.

Recycling of mobile phone can pose severe challenges for the central government, local authorities and the workers who are engaged in the process of mobile phone recycling. Concerning the risks, respondents indicated that recycling of mobile phones could cause land pollution if not well managed. Indeed mobile phone recycling requires well-developed systems that ensure that every component of the mobile phone is well-handled and does not go the environment. It means that after the collection of valuable metals, there must be a way to dispose of other parts of the mobile phone, either to be used for other things or disposed of well.

Financial challenge was one of the issues that came up. The respondents opined that recycling of mobile phone would require a high injection of capital and which at present the economic situation in the country may not permit most people to venture into this business. This is because recycling of mobile phone as in the sense of converting parts into new phones requires sophisticated machines and technology which requires money to do that.

The issue of reduction in the quality of the mobile phone being recycled also emerged from the study. This may be true in some sense, especially when juxtaposed with the fact that most of the valuable materials may not be in their original state. Results from the study also revealed that without any regulations to check the activities of mobile phone recycling, mobile phone theft would increase. The end-user having his or her information passed on to other people was another challenge that emerged from the study.

Getting access to the required quantity of mobile phone waste to recycle was another challenge the recycling companies face. It has, therefore, compelled these industries to open other branches in other West African countries. The fluctuation in the world market price of used mobile phones was another problem that the recycling companies also face. Again, most of the respondents said that they would not buy used phones. Those who opined that they would purchase used phones gave various reasons they will consider before buying a used phone. Most of them indicated that they would buy a used phone that has features their current phone doesn't have.

Another issue that came up had to do with the exposure of vital information. It was revealed by some of the respondents that in the process of giving back their used phone for recycling, some of their essential information was exposed to a third party that led to a fraud incident.

The possibility of contracting a disease in the course of mobile phone recycling, especially in the process of dismantling and separating parts of the phone was very high. This is because most of the informal recyclers don't wear protective clothing and gloves. The informal recyclers were not able to tell precisely which chemicals were in the phones that when being disassembled were dangerous to their health, but they did emphasise that there were toxic substances which were dangerous to the health of people especially people at Agbogbloshie.

Important views were expressed by industry players in the recycling sector. It also emerged from the study that informal collectors were at risk of being knocked down by a vehicle. There have been occasions where collectors have been knocked down by a vehicle in the course of transporting the mobile phone waste to the recycling companies. Some of the collectors also burn some of the parts to retrieve the precious metals they want. The reason is that they don't want to carry bulky goods to the recycling companies. The burning of materials to extract precious metals from the phones increases their exposure to smoke, and other toxic fumes hence increase their level of vulnerability. Even though recycling of mobile phone is an excellent system for ensuring the sustainability of the limited natural resources use to produce mobile phone, there is also the risk of having your information passed on to other people. This is because experts can have access to your information even when the memory card and chip are not in the phone.

6.3 Conclusions

The following conclusions were arrived at based on the discussions of the findings. The first point is that respondents were willing to give their phone for recycling, but high recovery price was the most important thing they will consider before giving their phone out for recycling. Most respondents were of the view that manufacturers should bear the cost of recycling used mobile phone while very few indicated that it should be a common responsibility of both users and manufacturers. Most of the respondents were also willing to contribute to the recycling of their used phone.

For the second research question which seeks to understand respondents' awareness of how mobile phone waste can be managed and regulated, three issues came up. The first is that the best regulatory framework for people to recycle their phones is a legislative instrument. Respondents' awareness of the existence of the e-waste law was very low. Most of them

were not aware of the e-waste law. Although, the law seems promising the role of the informal sector seems missing in the new e-waste law.

With regard to the last objective, the study demonstrated that mobile phone contains both highly toxic substances and valuable materials that can be recovered to garner the double value of both environmental protection and resource conservation. From the study, it emerged that mobile phone recycling provides employment opportunities for people in both the informal sector and the formal sector. It is also a source of revenue to the government and sustains the limited natural resources used to produce new phones.

With regard to the risks, respondents indicated that recycling of mobile phone could cause pollution if not well managed. Financial challenge was another issue that came up. This is because, to set up a recycling company high injection of capital is required and the economic situation in the country presently may not permit. Again, some of the respondents said that mobile phone recycling would increase phone theft because people will steal other people's phones and sell to scrap buyers.

Environmental health risk, occupational risk, including hazards encountered by informal e-waste collectors, and digital security were some of the risks that emerged from the study.

6.4 Recommendations

Mobile phones should be designed in such a way that at the end of their life, they can be recycled easily. The hazardous substances in them should be replaced with non-hazardous ones.

I, therefore, recommend that more education be given to people on the effects of disposing of mobile phone waste anyhow on the environment.

The current e-waste law should be reviewed to specify the role of the informal sector workers and further engage other stakeholders for effective implementation.

From the study, it was revealed that most respondents of the survey stockpile their used phones. It is possible they stockpile them because they don't know what to do with it. I recommend that recycling bins be placed at vantage points for people to drop off their used phones for recycling.

Again, I recommend the formalisation of the mobile phone recycling sector for it will create a lot of employment opportunities, and the government can also generate more revenue from the industry. The constant harassment of e-waste workers should also stop.

Furthermore, to enhance reuse of mobile phone in Ghana, there is a need for the establishment of a testing and refurbishing system to verify the quality of used phone.

The study also calls on policymakers to pay attention to mobile phone recycling industry as a sustainable way of handling their disposal practices, and mitigate any potential negative impact on the economy.

6.5 Future Research Suggestions

Future research should examine who is more likely to recycle his/her phone: the youth, the aged, males or females. For this will inform policymakers on the strategy to adopt to get those who are not likely to recycle their phone to do so. Again, future research should also examine whether one's level of education can increase his or her willingness to recycle mobile phone.

Future research should critically look at how recycling can make the price of mobile phone cheaper. Research should also be conducted on the type of phone people are likely to give out for recycling and why that type of phone. The issue of a few women in the mobile phone recycling chain should also be examined in future research.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Household questionnaire survey for a study on “Mobile phone Recycling and Reuse in Accra Metropolis: Prospects and Challenges”. This research is being carried out in partial fulfilment of an award of MPhil degree in Geography and Resource Development in the University of Ghana. The information being solicited in this survey is purely for academic purposes as stated herein and therefore, confidentiality will be strictly observed. Please tick or write a suitable response in the space provided. Thank you for your decision to participate

Questionnaire No. Name of Community.....

SECTION A: BACKGROUND INFORMATION

- 1 City** **Neighbourhood**
.....
- 2 Age** (as of your last birthday)..... Years
- 3 Sex:** 1. Male 2.Female
- 4 Marital status:**
- | | | | |
|----------------------------|--------------------------|--------------|--------------------------|
| 1. Single (never married) | <input type="checkbox"/> | 4. Divorced | <input type="checkbox"/> |
| 2. Consensual/cohabitation | <input type="checkbox"/> | 5. Separated | <input type="checkbox"/> |
| 3. Married | <input type="checkbox"/> | 6. Widowed | <input type="checkbox"/> |
- 5 Occupation:**
- | | | | |
|-----------------------------------|--------------------------|------------------------------------|--------------------------|
| 1. Professional/technical/manager | <input type="checkbox"/> | 6. Unemployed | <input type="checkbox"/> |
| 2. Sales/services | <input type="checkbox"/> | 7. Agriculture | <input type="checkbox"/> |
| 3. Skilled manual | <input type="checkbox"/> | 8. Pensioner | <input type="checkbox"/> |
| 4. Unskilled manual | <input type="checkbox"/> | 9. Other (<i>Please specify</i>) | |
| 5. Clerical | <input type="checkbox"/> | | |

6 Household size

7. Tribe:

- | | | | |
|---------------|-----|----------------------------------|-----|
| 1. Akan | [] | 3. Ewe | [] |
| 2. Ga/Adangme | [] | 4. Mole Dagbani | [] |
| 5. Hausa | [] | 6. Others (Please specify) | |

8. Religion:

- | | | | |
|--------------|-----|---|-----|
| 1. Christian | [] | 3. Traditional | [] |
| 2. Moslem | [] | 4. Others (<i>please specify</i>) | |

9 What is your average monthly household income? (in - GH¢)

- | | | | |
|------------------|-----|------------------|-----|
| 1. 1 – 500 | [] | 4. 1,501 – 2,000 | [] |
| 2. 501 – 1,000 | [] | 5. 2,001 – 2,500 | [] |
| 3. 1,001 – 1,500 | [] | 6. Above 2,500 | [] |

10. What is your highest level of education?

- | | | | |
|---------------------------------|-----|---|-----|
| 1. None (No formal education) | [] | 5. HND/Diploma | [] |
| 2. Primary | [] | 6. Graduate (Tertiary) | [] |
| 3. JSS/JHS/Middle school | [] | 7. Postgraduate | [] |
| 4. SSS/SHS/Vocational/Technical | [] | 8. Others (<i>Please specify</i>) | |

EXPERIENCE WITH MOBILE PHONE USAGE

11. When did you use your first mobile phone?

Please state.....

12. What was the brand?

- | | | |
|-------------|--------------|--------------------------------|
| [i] Samsung | [ii] Infinix | [iii] Nokia |
| [iv] Tecno | [v] HTC | [vi] Others (Please state) ... |

13. How many times have you changed your phone over the past five years?

- | | | | |
|----------|------------|-----------------------|----------------------|
| [i] Once | [ii] Twice | [iii] More than twice | [vi] More than twice |
|----------|------------|-----------------------|----------------------|

20. Which department do you think should take responsibility for waste mobile phone recycling?

- [i] Government [ii] Manufacturer [iii] Seller
[iv] Consumers [v] Communication operator [vi] Common responsibility

21. Do you agree that consumers are the ultimate beneficiaries of mobile phones and that they should pay a fee/ an amount of money for the recycling of their waste mobile phones?

- [i] Yes [ii] No

If Yes, please answer question 22 and if No please skip question 22

22. If consumers have to pay part of the waste mobile phone recycling costs, what percentage of the recycling costs would you accept (%)?

- [i] 0-5 [ii] 6-10 [iii] 11-15
[iv] 16-20 [v] 21-25 [vi] more than 26

23. Would you be willing to buy a used mobile phone?

- [i] Yes [ii] No

24. What would be your prerequisites/conditions for buying a used mobile phone?

- [i] Mobile phone is not more than one year old
[ii] It has features that my current phone does not have
[iii] It is cheaper to buy a used phone than a new one
[iv] I know the last owner/ buy it at first hand
[v] Others, please specify

THANK YOU FOR YOUR PARTICIPATION

Please, kindly provide me with the following details in case I need to come back to you for further clarification.

Mobile phone number.....

House No:

Description of residence:

Date:

APPENDIX 2: STAKEHOLDER INTERVIEW GUIDE

SECTION A

BACKGROUND INFORMATION

1. **Name of community**
2. **Gender**.....
3. **Age**
4. **Location**
5. **Date**
6. **Occupation**.....

SECTION B

INTERVIEW WITH FORMER RLG

1. What are some of the risks you encounter in your work?
2. Are there any risks associated with mobile phone recycling?
3. How do you recycle mobile phones?
4. Do you have regulations that are in conformity with the international community

INTERVIEW WITH ENVIRONMENTAL PROTECTION AGENCY (EPA)

1. What is your role in EPA?
2. Do you have any platform that hosts recycling companies in Ghana?
3. Do you have data on the recycling companies in AMA?
4. Is there a company that recycles the motherboard of mobile phone in Ghana?
5. How many recycling companies do you have?
6. What kind of regulation do you have for recycling?
7. How do you monitor these recycling companies?

8. What are the challenges you are facing with the establishment of the proposed recycling company?

INTERVIEW WITH BLANCOMET RECYCLING COMPANY

1. What do you do?
2. Do you recycle the mobile phones you receive here?
3. Do you receive mobile phones only in Ghana?
4. What do you do to the mobile phone batteries?
5. Do you extract any component from the motherboard in Ghana here?
6. How are you able to know there is a mineral in the various parts
7. Which of the phones that you recycle have more value?
8. Do you follow regulations in your job?
9. What are some of the health risk you encounter in trying to dismantle these phones?
10. Do you encounter some economic risks?

INTERVIEW WITH ATLANTIC HOLDINGS

1. Do you have a reliable source where these computers or mobile phone equipment's come from? How do you get them?
2. You said some come through ports. Which countries are they coming from?
3. Where do you get the students you train to dismantle and repair mobile phones from?
4. What kind of training do you give to the students?
5. Which device do you get most? Mobile phones or laptops?
6. Do you accept every brand?
7. Do you do all the recycling here?
8. Is the dismantling done manually?
9. Do you export to recycling companies abroad after the manual dismantling?

- 10.** Do you recycle the batteries of the mobile phone?
- 11.** Are there companies that recycle plastic screens or glasses?
- 12.** How can mobile phones be made repair friendly?
- 13.** Is there something that can be improved upon in terms of maybe the design of mobile phone such that recycling it will be easy?