Towards a circular economy in South Africa - what are the constraints to recycling mobile phones?

Peter Desmond MA(Oxon) FCA MBA FRSA *peter@growthinternational.com*

Summary

There are limited amounts of non-renewable resources which we are using to make everyday products. In addition, developments in electronic devices have resulted in increasing amounts of waste. This paper identifies, in the context of recycling mobile phones in South Africa, the constraints which inhibit progress towards the creation of a circular economy where waste is considered a resource. Published literature and semi-structured interviews are used to identify these constraints and examples proposed of how the constraints can be overcome through changes to legislation, policy, infrastructure, financial incentives and consumer behaviour. Such changes will require all key stakeholders to work in collaboration to recover the valuable resources and reduce waste.

Peter Desmond MA(Oxon) FCA MBA FRSA *peter@growthinternational.com*

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Abbreviations

CE – The Circular Economy

EMF – Ellen MacArthur Foundation

EPR – Extended Producer Responsibility

EU – European Union

E-waste – Electronic waste - small items of equipment such as computers, printers, copiers and mobile phones which contain scarce and hazardous materials**.**

LE – The Linear Economy

MPPI - Mobile Phone Partnership Initiative

NGO – Non-Governmental Organisation

PESTLE – Political, Economic, Social, Technological, Legal, Environmental

SA – South Africa

UN StEP – United Nations Solving the E-Waste Problem

WEEE - Waste Electrical and Electronic Equipment

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Preface

The problem of scarce resources and e-waste arises from the way our modern economy currently operates: it is 'linear' in design and is powered by increasingly expensive fossil fuels, relies on continual economic growth and generates waste which can be hazardous and is often disposed of in unsafe environments in developing countries. An alternative approach to this linear economy is an economy which is more 'circular' in design, benefitting society and nature by reusing products and materials to realise their maximum value.

This paper looks at the constraints that inhibit the creation of a circular economy in the context of recycling mobile phones in South Africa. It also considers briefly some ideas of how these constraints can be overcome. In researching this topic secondary sources were used including academic journal articles, newspaper articles, books, reports, blogs and websites. In addition primary research was carried out by means of interviews with academics and practitioners in Europe and South Africa.

There are many people I would like to thank for their encouragement and support. To the people I interviewed during the primary research phase of this project. To Yvonne, Steve, Alison, Jojo, Katherine, Jo, Shova, Mirela, and Alison for their critical feedback on my methodology and drafts. To Professor Hubert Schmitz, my supervisor, for suggesting the subject of the circular economy and keeping me on track. And above all, to my wife, without whose support and patience I would not be where I am now in life generally, let alone have finished this piece of writing.

Chapter 1 – Introduction

1.1 The Problem

There are two elements to the problem that I am researching: resource depletion and increasing amounts of electronic waste. There are limited amounts of non-renewable resources on our planet: they comprise metals, minerals and other natural substances which are mined and made into products used in our everyday lives. These resources are subject to volatility in price[1] and reduced availability[2] as virgin resources are depleted.

Furthermore, developments in technology and personal computing have resulted in an increasing amount of e-waste which is not always disposed of in a safe or responsible manner. The UN's StEP initiative estimates that in 2014 the total global e-waste generated was 41.8m metric tonnes (Mt) which comprised of 3m Mt of small IT equipment including mobile phones. They go on to define e-waste as a term "to cover items of all types of electrical and electronic equipment and its parts that have been discarded by the owner as waste without the intention of re-use" (UN StEP, 2015). In this paper e-waste refers only to electronic waste[3] and excludes electrical waste[4]. The methods for disposing of electronic equipment are more complex than electrical items because of the greater amounts of hazardous[5], scarce and valuable materials.

1.2 Linear and Circular Economies

The problem of scarce resources and e-waste arises from the way our modern economy currently operates: it is 'linear' in design where products are made, used by consumers and disposed of without a great deal of thought to environmental sustainability. This linear economy (Ellen MacArthur Foundation 2013a) is powered by increasingly expensive fossil fuels, relies on continual economic growth and generates waste.

An alternative approach to LE is a Circular Economy (CE) (Ellen MacArthur Foundation 2013a). CE is an industrial system which benefits society and nature; it aims to reuse products and the materials they are made of to realise their maximum value, as in a natural ecosystem. It is an industrial system that is intentionally regenerative in its design. It replaces the 'end-of-life' concept with restoration and moves towards the use of renewable energy. It reduces the use of toxic chemicals, which impair reuse, and aims to eliminate waste through the considered design of products and systems[6]. In order to achieve this transition from LE to CE, a change of the entire operating system is seen by some experts to be essential (Webster, 2015).

CE thinking and methodology is now being used in business applications. For example, recycling toner cartridges (HP), selling of light rather than light fittings (Philips) and motor vehicle take-back schemes (Renault). The lessons learnt in these environments are being considered for other applications including mobile phones.

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[1] Since 2000 increases in commodity prices have balanced out all the price declines of the 20th century (Ellen MacArthur Foundation, 2013a).

[2] Since 1980, the yield in concentration from copper mining has reduced from 0.7% to 0.55% (Ellen MacArthur Foundation, 2013a)

[3] Smaller items such as computers, printers, copiers and mobile phones.

[4] Larger domestic appliances such as fridges, cookers, toasters and kettles.

[5] A mobile phone contains between 500 and 1000 components. Many of these include toxic heavy metals such as lead, mercury, cadmium and beryllium and hazardous chemicals, such as brominated flame retardants (Cobbing, 2008)

[6] This is summarised in Figure 1 which shows how waste from two types of nutrients (biological and technical) can provide inputs to create increasingly 'closed loop' processes.

Alternative frameworks to CE were considered for this study: John Elkington's Triple Bottom Line[7] and the International Organization for Standardisation's ISO 14001 Environmental Management Standard (BSI Group, 2015). However, these focus primarily on the impact of systems and outputs whereas CE considers the opportunities for creating closed-loop processes, the integration of the whole system from design to disposal and its more holistic approach to sustainability.

1.3 Research question

The analysis and creation of CE is a complicated task because it varies with the product and location and has various stages. This paper will therefore concentrate on a particular product – mobile phones – and address a particular problem in a specific setting. It will explore the constraints of South Africa (SA) moving towards creating CE using the case study of recycling mobile phones, through reuse, reselling and repair when they reach the end of the use.

The research question that this paper aims to answer is, *"What are the constraints to recycling mobile phones in South Africa?"*

Constraints are researched through primary and secondary sources and analysed using a framework which categorises the constraints identified into Political, Environmental, Social, Technological, Legal and Economic (PESTLE). While these constraints can often be overcome, this paper is primarily concerned with identifying constraints themselves. Their resolution will be mentioned briefly.

This paper adds to the current body of literature in two ways: by bringing together the most insightful literature to date from other countries on recycling e-waste and mobile phones as well as by researching constraints to recycling mobile phones in SA through interviews with academic researchers and practitioners.

1.4 Mobile Phones

Mobile phones are quite ubiquitous in the modern world. It is estimated that the number of mobile phones in the world is greater than the number of traditional landlines, the infrastructure for which is greater than that for installing cellular communications. It is estimated that in 2013 there were 7.1bn mobile phone subscriptions (Ahonen, 2013). Another estimate is that in 2014 there were 4.5bn mobile phone users in the world compared to 1.2bn traditional fixed landlines (Mobiforge, 2015).

Data on the amount of mobile phones sent to landfill globally each year is difficult to isolate as records are not kept by landfill operators to this level of detail. It is therefore not currently known how many mobile phones are sent to landfill or incineration each year in SA. Yet, constraints to the management of e-waste are, for the most part, similar to constraints to recycling mobile phones.

Even though mobile phones form a small part of the e-waste stream in SA, they possess relatively greater amounts of valuable materials in comparison to other types of e-waste, such as computers, photocopiers and printers (Ramirez, A. et al., 2013).

1.5 South Africa

[7] Triple Bottom Line focuses on the economic, social and environmental drivers of sustainability (Elkington, 1999).

SA was chosen for research as it is a middle-income, emerging market (Central Intelligence Agency, 2015), with characteristics of both developed and developing countries. The prevalence of mobile phones is high in SA: amongst a population of 53m, 89% own a mobile phone, the same percentage as USA (Pew Research Center's Global Attitudes Project, 2015). Yet for a developing country it generates a relatively high volume of e-waste: in 2014 it produced 6.6kg per person compared to 4.4kg in China and 1.3kg in India; UK in contrast generated 23.5kg and the USA 22.1kg (UN StEP, 2015).

SA has also started to create a waste recycling infrastructure with city councils in Cape Town and Johannesburg introducing domestic collections of waste which are sorted and disposed of at official recycling centres. Waste management legislation has been in place since 2010 which is considered by one expert as being of a high standard but not yet fully enforced[8]. The Western Cape Province has ambitions to be a manufacturing hub in Southern Africa which could include remanufacturing as a step towards the creation of CE[9].

1.6 Relevance to International Development

CE will have an impact on the development of SA through job creation and economic growth. The government is actively encouraging the development of 'green' industries as a means of increasing the number of people in employment.[10]

The informal economy is part of this solution. In SA it provides incomes for people who earn a living by collecting waste from domestic bins and selling them onto recyclers. If, through the creation of co-operatives, these street waste pickers can be included in the formal economy, the official employment rate can be increased, tax revenues generated and workers' incomes become more sustainable.

The relevance of CE to the economic development of SA can be seen in an article in the Guardian newspaper (Perella, 2015) which considers a tyre recycling initiative, REDISA (2,505 jobs created with 98% to previously disadvantaged people) and Coca-Cola's involvement in 'bottle-to-bottle' recycling plants (49% recovery rate). It is hoped that these initiatives will be replicated across the country through job creation in new social enterprises. However, despite CE methodology gaining traction in the business world it has yet to be applied to any great extent in the context of international development[11].

[8] A comment from one of the Trade Association representatives interviewed in SA.
[9] A comment from one of the Consultants interviewed in SA
[10] A comment from one of the City Council employees interviewed in SA.
[11] The author of this paper attended two conferences on CE as part of data gathering process and in both cases he was the only person considering CE from the perspective of international development; the remainder of the delegates (in excess of 100 at each event) were considering CE from corporate profitability and sustainability perspectives. This was further confirmed by one of the consultants interviewed who had researched CE for a report for an international development agency; he was unaware of any other academic institution considering this subject as a development option apart from the Institute of Development Studies.

1.7 Structure of the paper

Following this introduction, Chapter 2 defines the terms of LE, CE and recycling. Chapter 3 outlines the methodology of research and analysis. Chapter 4 summarises the extent of constraints to recycling e-waste and mobile phones that exist in a number of countries around the world. Chapter 5 analyses the constraints to recycling mobile phones in SA as evidenced through a series of semi-structured interviews. Chapter 6 provides some potential ways that the constraints identified in Chapters 4 and 5 might be overcome. Chapter 7 draws together the conclusions from the research, the difficulties of creating CE for mobile phones in SA, proposals for policy change and areas of possible future research.

Chapter 2 – Definition of Terms

2.1 Linear Economy

Our modern economy is 'linear' in design: products are made, used by consumers and disposed of without a great deal of thought to environmental and social consequences.

The problems associated with a Linear Economy (LE) can be seen from the raw materials within mobile phones: they are subject to volatility in price[12] and reduced availability as virgin resources are depleted. Consequently there is a strong case for recycling mobile phones and releasing the value of materials that they contain.

2.2 Circular Economy

CE involves the redesign of products so they are repairable and longer-lasting, devices are re-used, failed components are replaced, core elements refurbished, precious metals extracted and remanufactured into new products. This approach would keep mobile phones away from landfill while recovering high value precious metals and rare earths. This paper will consider the recycling elements of CE.

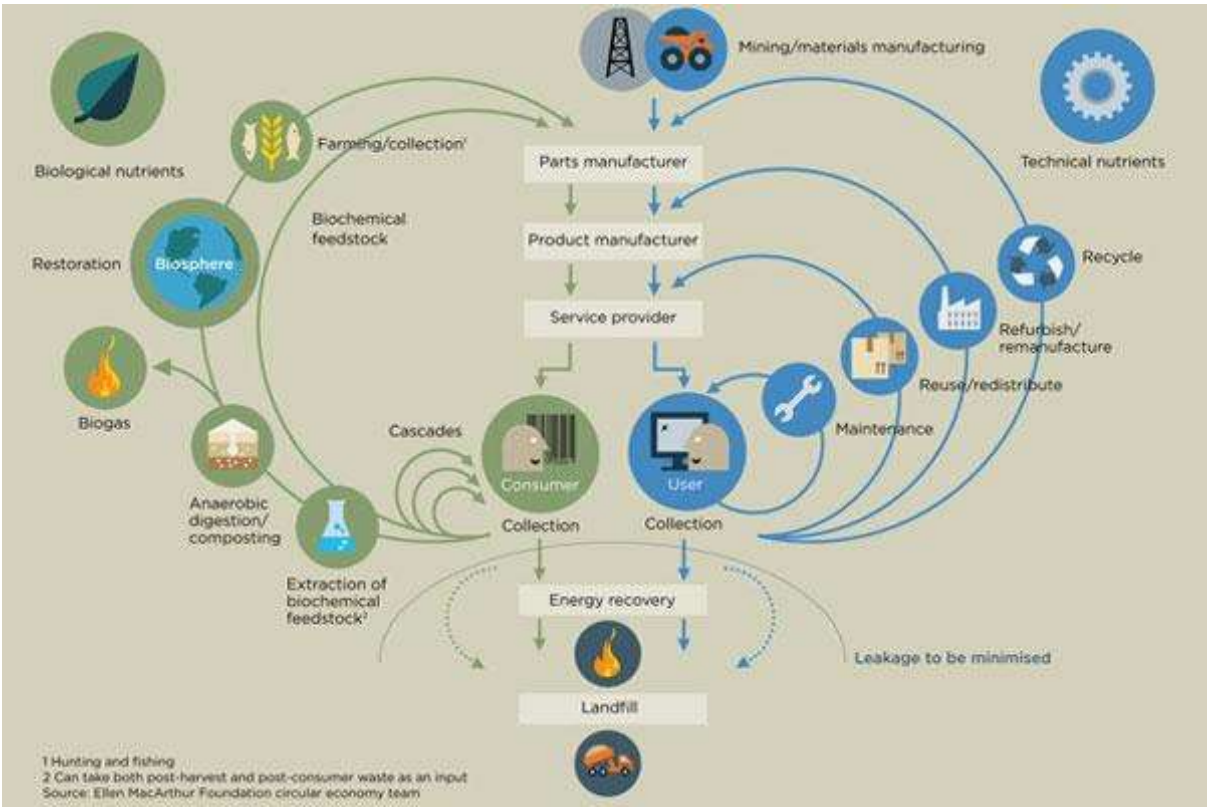
The idea of CE has not come from a single school of thinking but has originated over numerous decades from a number of different frameworks, including biomimicry[13], industrial ecology[14], performance economy[15] and cradle-to-cradle principles[16].

The Ellen McArthur Foundation (2013b) has built on this earlier thinking with McKinsey & Co and explain CE diagrammatically in Figure 1. They propose that CE has the potential of producing cost savings as it reduces exposure to market price fluctuations, reduces energy needs from non-renewable sources and, through recycling, releases valuable materials and energy which is being retained in existing products. The tighter the circular loops, the less needs to be done to

[12] Since 2000, increases in commodity prices have balanced out the price declines of the previous 100 years.
[13] John T. Lyle started looking at how biomimicry could be applied beyond the agricultural sector using a concept called 'regenerative design' in the 1970s where dead organisms provide nutrients for the next generation (Lyle, 1996).
[14] Industrial Ecology was the name given to the study of introducing circular processes into industrial systems by Walter R. Stahel in the mid-1970s
[15] Stahel and Reday-Mulvey (1976) further suggested that a performance economy could encourage repair, reuse and recycling of consumer goods by moving away from ownership to renting products from washing machines to clothes.
[16] Michael Braungart and Bill McDonough (2002) proposed an alternative to 'cradle-to-grave' thinking through 'technical' materials being reused in new technologies and 'biological' waste becoming nutrients at the end of their useful lives.

components before they are reused, and as a result the less embedded value of labour, materials and energy is lost.

Figure 1 – Circular Economy (Ellen MacArthur Foundation 2013a)

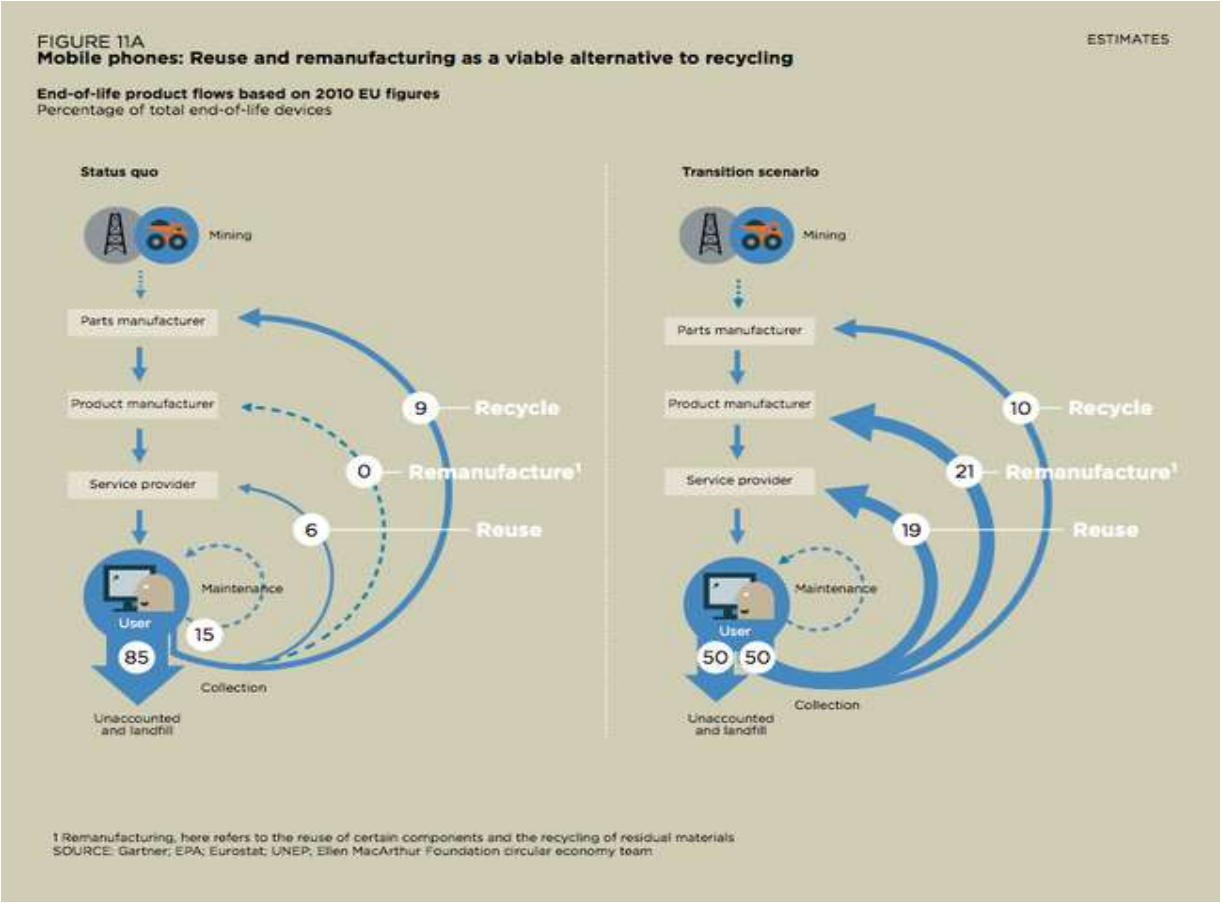


Lessons learnt from successful CE applications in different sectors can be applied to the mobile phone industry. For example Philips Lighting, instead of selling light fittings, sell light for a fixed monthly sum, which includes repair and replacement. Applying this to the mobile phone industry, a consumer could pay for the use of the phone and, at the end of the contract, the old handset would be taken back by the seller in return for a new phone and a new contract. This would replace the popular current system of free upgrades which creates stocks of useable but unused handsets.

CE for mobile phones involves the recycling of their component parts, as well as reducing the amount of e-waste that ultimately goes to landfill and incineration, at the same time as recovering high value metals, minerals and rare earths. Whilst the amounts in each phone is small, the large volumes that can potentially be processed could make this commercially viable.

EMF has also researched the potential for creating CE for mobile phones and suggest that there are commercial opportunities to reduce the amount of mobiles phones going to landfill around the world from 85% to 50% (Ellen McArthur Foundation, 2013a). The diagrammatic explanation of how recycling loops can be increasingly tightened to achieve this is shown in Figure 2 below.

Figure 2 – Mobile Phone and the Circular Economy (Ellen MacArthur Foundation, 2013a)



2.3 Recycling

Through the literature review the following strands of CE have been identified for consideration. In this paper the term 'recycling' of mobile phones is defined as being made up of the first three of these strands as shown in red in Figure 3 below (the author's own design).

a) Reuse – a phone is passed onto another person to use with its original specification intact without major refurbishment from its original specification, often to friends and family.

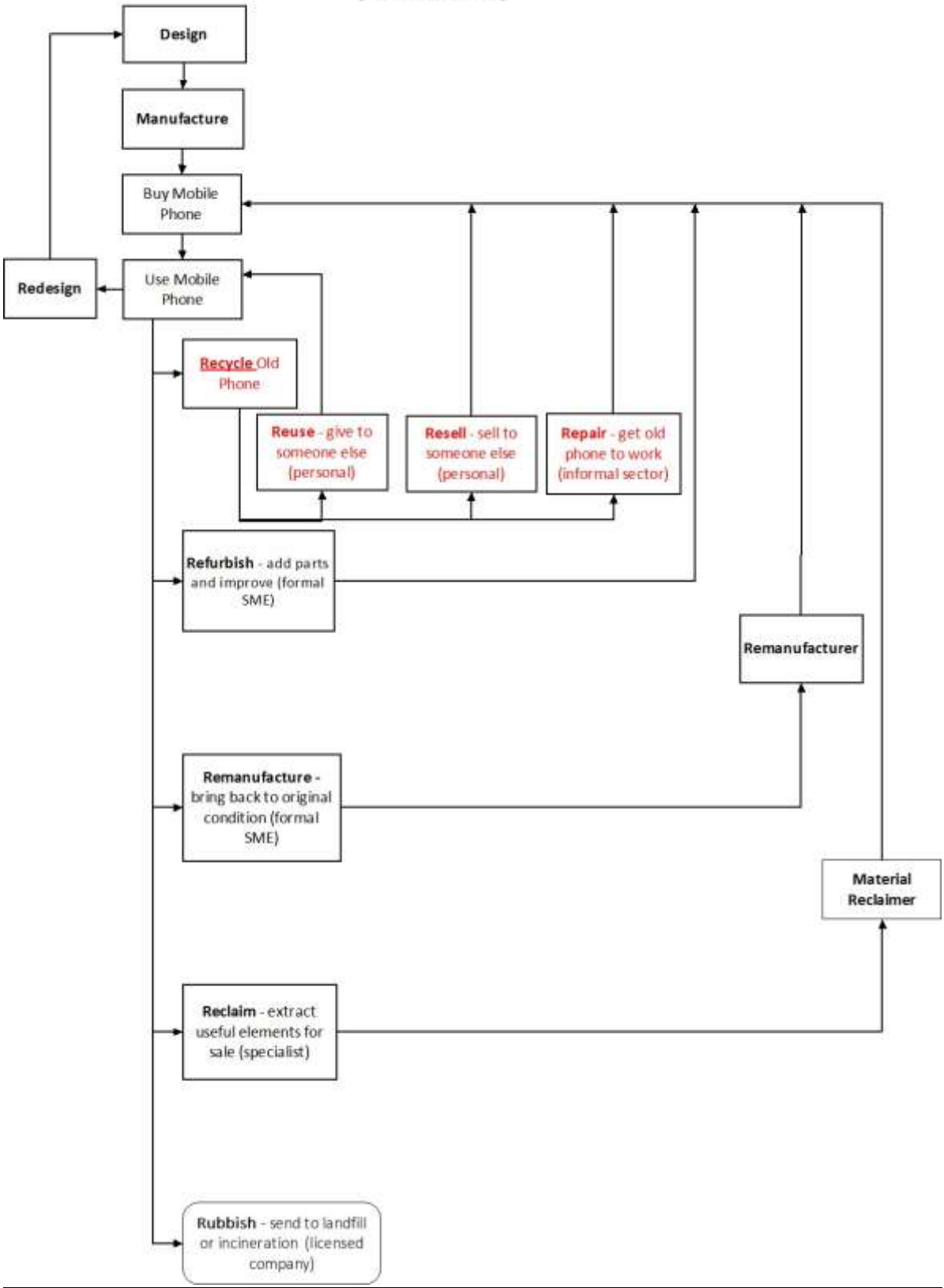
b) Resell – the current market value of the phone is realised from a third party for cash or equivalent; these phones are either refurbished by the buyer or sent in bulk for auction.

c) Repair – when a device is broken and its useful life can be extended through the refurbishment and replacement of failed components.

This paper will focus on these three strands. Beyond recycling there are three other strands not considered in detail in this paper: refurbish (new parts are added to the device in order to restore it to working order), remanufacture (the device is brought back to its original condition with some form of quality guarantee attached), and reclaim (precious metals, plastics and printed circuit boards are extracted and sold in the market).

Recent writers on CE are now suggesting that, "A change of the entire operating system seems necessary" (Webster, 2015 p52). For example, consideration is now being given to the need for the redesign of mobile phones to create CE by the manufacturers of modular phones such as Fairphone and Phonebloks.

Figure 3 - Towards a Circular Economy for Mobile Phones
[Source: the author]



Chapter 3 – Methodology

The research for this paper comprised a combination of secondary sources (published academic literature, websites, blogs, and magazine articles) and primary sources (interviews with academics and practitioners in Europe and SA). The outputs were categorised, compared and analysed to determine the key constraints to the recycling of e-waste in general and mobile phones in particular.

3.1 Secondary Sources

The purpose of the literature review is to identify the constraints to the recycling of mobile phones that have been seen in other parts of the world which can provide insights into the constraints that exist in SA. Little has been published on the subject of recycling of mobile phones in SA in comparison to the amount of literature on e-waste management.

3.2 Primary Sources

Primary research was also undertaken to identify constraints to recycling mobile phones that exist in SA. This was based on semi-structured interviews conducted face-to-face, via Skype, by telephone or by email. One focus group in SA was undertaken with five representatives from a single NGO.

Participants in the research project were based in either Europe or SA. They were either existing contacts in the sector or referrals. A study trip to SA was undertaken in June and July 2015 to Cape Town and Johannesburg including a visit to an e-waste recycling facility.

As a result of the paucity of published literature on the subject of recycling mobile phones in SA, the interviews with key stakeholders in SA were extended in number and depth to better access current thinking and practice.

The research was carried out on an anonymous and confidential basis in accordance with ethical guidelines[17]. The bibliography contains the names of the people who were interviewed; however, in this paper analysis is undertaken by stakeholder group rather than attributing comments to one person individually. This approach has been adopted in order to provide an indication of which stakeholder made the comment but at the same time maintaining personal anonymity.

A total of 55 people were approached to be interviewed either through existing contacts or by recommendation from others. 24 people were actually interviewed: 19 on a one-to-one basis and 5 in a single focus group session. 19 of the interviewees were based in SA, 4 in the UK and 1 in Europe. All but one of the target stakeholder categories were covered by the 23 interviewees: despite recommendations, it was not possible to interview a government policy maker. However, a government policy adviser was interviewed who provided insights into constraints arising from the existing legislation in SA and the challenges facing policy makers and regulators to implement and enforce new legislation.

[17] This means that comments made by the interviewees included the research paper but nothing would be attributed to them directly.

3.3 Framework for Analysis of Constraints

The PESTLE[18] framework was used to analyse the constraints identified in the literature review and interviews. It provides a means of reviewing the types of constraints from different angles. The other framework considered for analysis was Force Field Analysis but it was concluded that PESTLE provided the greater flexibility in considering the broader implications of constraints.

Political: The extent to which a government can influence the economy or a certain industry. They include tax, labour and environmental policies, trade restrictions and tariffs.

Economic: The financial performance of an organisation and its decision-making processes. They include inflation, interest and exchange rate movements, purchasing power of consumers, production efficiencies as well as supply and demand factors.

Social: The social environment and the impact on people's behaviour and decision-making. They include cultural, media and population trends, and aspirations for a certain lifestyle.

Technological: Innovations in technology and the impact on market behaviour of technical developments, research, process efficiency and design.

Legal: Impact on costs and efficiency: a) external i.e. government controlled laws and regulations (consumer and employment), and b) internal i.e. standards and controls that businesses implement themselves (quality and safety).

Environmental: Ecological and environmental aspects such as weather and climate as well as those that impact biodiversity and the natural world such as the toxic contamination from the disposal of electronic equipment in a landfill site.

The research reveals that constraints overlap and can be found in more than one category. To facilitate analysis each constraint was allocated to its most relevant category. Some constraints are mutually dependent and so the solutions to overcoming them need to take this into account. Furthermore, cross-linkages and contradictions between the categories have been recognised in the text. For example the culture of keeping old phones in drawers is a social constraint and also an economic one: without sufficient financial incentives users are less likely to resell surplus handsets.

Chapter 4 – Constraints Identified in the Literature Review

This chapter is not a critical evaluation of the academic literature and other resources. Rather a selection of the most insightful published material is reviewed in order to inform the analysis of constraints in SA identified through the research interviews. Sources of literature included books, articles, journals, reports, blogs and websites. No systematic reviews were identified covering the subject areas being researched.

4.1 Political Constraints

Government policy has a major role to play in how e-waste is managed on a national and local level. In Ghana and India the lack of an enabling environment, including financial and other incentives, is a major constraint for the creation of CE, particularly for entrepreneurs to set up

[18] This is a mnemonic principally used in a business context to support a SWOT analysis to determine strategic options. PESTLE denotes constraints which are: P for Political, E for Economic, S for Social, T for Technological, L for Legal and E for Environmental.

informal repair businesses (Bleekemolen, 2013 and Rangaswamy & Nair, 2010). In comparison China has established pilot projects, such as Dalian, specifically created as CE eco-cities to conserve water, materials, energy and land. However, there have been constraints to their full implementation, such as the lack of incentives for older industries to 'green' their operations and the lack of financial support for new CE initiatives, along with poor participation by public (Geng, 2009).

Despite passing legislation to encourage CE, the Chinese government has not put into place any incentives, financial or otherwise, which would give preference to companies that sell products with circularity as a key strategic option (Shi, 2009). In contrast, the EU political and regulatory environment has resulted in an increase in the cost of waste management which has been borne to a large extent by the producers rather than consumers (Costa, 2010). This approach has developed into the legislation for Extended Producer Responsibility (EPR) where manufacturers are required to build in the cost of managing end of life disposal processes to the initial price of a product or bear the cost themselves.[19]

The lack of a recycling infrastructure, both private and public, has been a political constraint in both China and India which has inhibited the growth in the number of repair entrepreneurs (Zengwei, 2006 and Dwivedy, 2012). This has been particularly noticeable with the informal sector not engaging with formal waste management systems (Chaturvedi & Arora, 2007). In both China and Denmark, the lack of co-ordinated national waste strategy has restricted the development of CE (Zengwei, 2006 and Ellen MacArthur Foundation, 2015).

4.2 Economic Constraints

Recycling of e-waste provides income to collectors, recyclers and managers of take-back schemes. Yet, despite growth in the number of phones entering India's e-waste streams from 2008 to 2010 there has been very little mobile phone waste available for recycling and opportunities for the creation of CE (Chaturvedi & Arora, 2007).

The same was found in the UK where mobile phones are not being recycled in sufficient numbers (Nnoromo & Osibanjo, 2008). This partly reflects consumer behaviour in keeping old handsets in drawers at home (UK), and also the tendency for repair to be a preferred option to buying new (India). Like many countries, Brazil only achieves collection rates for mobile phones of 10% as consumers are not aware of the potential for selling their handsets to manufacturers and retailers (Silveria & Chang, 2010). In Switzerland the situation is made worse by no formally organised recycling schemes being available (Wath et al., 2010).

Despite the fact that China has passed legislation with a focus on CE and sustainability, there is a lack of financial support from banks and other funders for research into CE opportunities as well as incentives to support water and raw material conservation. China experienced a rapid increase in e-waste collected and dismantled between 2000 and 2012. However, landfill is still the preferred option for disposal of e-waste as it is cheap despite its adverse environmental impact and its economic inefficiency (Lu et al., 2015 and Shi, 2009). Similarly in Ghana, business opportunities for CE are not being explored due to the lack of appropriate financing (Prakash & Manhart, 2010).

4.3 Social Constraints

[19] This is increasingly seen in the UK with the motor car industry and 'End of Life Vehicles - 2005' regulations: https://www.gov.uk/elv

Cultural traits and behavioural tendencies have a constraining effect on the creation of CE and the opportunities for recycling. For example in India, consumers don't always see repair as being a viable option for their ageing handsets and landfill is an easy solution (Doron, 2012). Cultural constraints are also seen in Finland where a study showed that 55% of respondents have two or more unused mobile phones at home and that unless collection systems are placed in convenient locations, recycling will continue to be difficult to encourage (Yla-Mellar et al., 2015).

The informal sector has a substantial involvement in recycling in China, India and Ghana with potential for creating formal employment. However, the standards to which they operate (health, safety and environment) are of poor quality and unsafe e.g. use of acid and fire to release valuable material from e-waste in India (Chaturvedi et al., 2011) and rework in China which doesn't last and is potentially hazardous (Chi, 2011). As a result further social constraints have been seen in the informal economy in both Ghana and China where the recyclers often lack the appropriate skills to handle e-waste in an appropriate manner (Prakash & Manhart, 2010 and Hicks et al., 2005).

4.4 Technological Constraints

Relatively few technological constraints were mentioned in the literature. This may reflect that technology for recycling usually only exists if sufficient funds are available for investment. Consequently the more sophisticated or hazardous treatment of e-waste is dealt with only in a few places in the world e.g. Taiwan, China and Belgium. Three articles mentioned one particular constraint: mobile phones are not designed for repair and longer life (Kibert, 2004, Nnorom & Osibanjo, 2008, and Hatcher et al., 2013); these three authors suggest that this constraint will continue as long as manufacturers in USA and China continue in an LE mindset.

One of the major constraints to the recycling of e-waste is the lack of sufficient strategic planning by business and other stakeholders. In both Brazil and India this is due to the sparsity of reliable data on the quantity of e-waste being generated; this information is required for the evaluation of potential investment in e-waste technology and infrastructure (Chaturvedi et al., 2011 and Araujo et al., 2012). In China the lack of technology has hindered the development of an informal recycling sector which has not been provided by government nor the private sector (Chi et al., 2011 and Hicks et al., 2005).

Another key constraint in the EU is the lack of proper enforcement of legislation. For example, an EU directive proposed in 2009 to require manufacturers to make mobile phone chargers with compatible connectors will not be implemented until 2016 through the Radio Equipment Directive (Ec.europa.eu, 2015). This has resulted in phone chargers being provided with every new phone even when the customer already has one (Edie.net, 2015).

4.5 Legal Constraints

The number of legal constraints is relatively high in the literature which reflects national concerns about the potentially adverse impact of e-waste recycling on the natural world, the environment and the people working in a potentially hazardous industry. Major challenges exist as to whether western recycling frameworks, such as the EU WEEE regulations, can be replicated in developing countries where much of the e-waste handling is undertaken by the informal sector in unsafe conditions (Wath et al., 2010 and Cobbing, 2008).

In many countries manufacturers are reluctant to consider issues which are not in their economic interest in addressing (Chaturvedi et al., 2011) and this results in difficulties in passing legislation for EPR (Chaturvedi & Arora, 2007). Unfortunately, legislation has failed to stop electronic

equipment being illegally imported into China from Western countries for 'reutilisation'; these items are often unusable and disposed to landfill or dismantled in workshops by migrant workers in unhealthy conditions (Hicks et al., 2005 and Shi, 2009).

Currently in the EU there is no co-ordinated legislation for the management of e-waste because there is no clear direction which would allow law makers to facilitate the creation of CE (Sthiannopkao & Wong, 2013 and European Commission, 2012). Furthermore, the lack of a co-ordinated approach to drafting legislation and producing guidelines will continue to hold back the creation of CE in the EU and the implementation of e-waste management systems in USA (EU CE Strategy Roadmap, 2015 and Oliveria et al., 2012).

4.6 Environmental Constraints

The recycling of mobile phones is likely to have a positive impact on the natural environment as it will reduce the amount of hazardous materials going to landfill. This has yet to be fully realised in India where informal workers could be more involved in the collection of e-waste to reduce the amount of toxic materials polluting the land (Chaturvedi, 2007 and 2011). There are also opportunities in China for small business entrepreneurs to reduce the release of toxic materials into the environment as they dismantle mobile phones (Yu et al., 2010).

This constraint will continue so long as the informal economy is involved in the recovery of value e.g. by stripping plastic casing to reveal copper wires for reselling. Herein lies a conflict between care for the environment and the need for industrial development to sustain economic growth, create jobs and provide for a rapidly growing population (Zhu et al., 2010 and Ely et al., 2011).

Collaborative moves towards improving the environmental impact of mobile phone disposal standards around the world have been seen recently with the creation in 2002 of the Basel Convention's Mobile Phone Partnership Initiative (MPPI): twelve manufacturers and three network operators agreed to develop and promote the environmentally sound management of end-of-life mobile phones. The five guidelines that have been developed under this initiative are now being used across the mobile phone industry (MPPI, 2012). It is too early to tell if this approach is viable. However, Pariatamby & Victor (2013) concluded that in Asia e-waste policy development cannot be piecemeal and needs to be integrated into a national approach to planning and development of environmental management guidelines.

4.7 Internal Constraints

The literature review focusses on constraints which were external to organisations. Internal constraints within manufacturers and network operators were not dealt with in the literature reviewed. Such constraints would include identifying strategic options, board decision-making, monitoring of trends in the market place and impact of developments in technology. These will need to be considered when looking at solutions to overcoming constraints which can involve participation by commercial organisations.

4. 8 Literature Specific to SA

Two pieces of published literature were found which related specifically to the recycling of mobile phones in SA. 44% of old mobile phones in SA are stored in drawers at home as consumers are reluctant to recycle their old phones (Vodaworld Magazine, Autumn 2009) - a social constraint. In SA there is a lack of take-back schemes run by the manufacturers or network operators (Nnoromo & Osibanjo, 2008) – an economic constraint. Both of these issues also emerged during the course of the primary research detailed in the next chapter.

Otherwise, there was very little literature dealing specifically on 'the recycling of mobile phones in SA'. A search via the Web of Science and Google Scholar[20] using these terms returned no results. A further search on 'recycling mobile phones' returned 469 and 139 results respectively, but most of these were very technical in nature.

Chapter 5 – Constraints from Primary Research Interviews

This chapter outlines the results of the primary research carried out with 23 participants who had knowledge and experience of the circular economy, mobiles phones or recycling in SA. In order to retain anonymity of the interviewees, comments have not been attributed directly but have been allocated to categories as follows: Academic, City Council, Consultant, Government Adviser, Manufacturer, Network Operator, NGO, Recycler, and Trade Association.

Recycling mobile phones in SA is a relatively new activity and currently does not operate on a large scale. For the most part, constraints mentioned by interviewees related to the general recycling of e-waste. However, they all acknowledged that the constraints for e-waste also applied, to a large extent, to the recycling of mobile phones.

115 constraints were identified during the course of the interviews and the number of constraints in each PESTLE category is summarised in Table 1.

Table 1 – Number of constraints identified in research interviews by category

Category of Constraint	Number Identified
Political	14
Economic	35
Social	26
Technological	13
Legal	16
Environmental	11
Total	**115**

Some of the constraints were mentioned by more than one interviewee. However, it cannot be concluded that multiple mentions make the constraint more significant than others as duplicated constraints may be a current issue in the minds of the interviewees rather than fundamental to the system.

Each constraint has been allocated a single dominant category. At the end of each PESTLE category in this chapter, a few key highlights are included of the constraints experienced in other countries from the literature review and how they relate to those identified in SA.

5.1 Political Constraints

Several interviewees pointed out that In SA the term 'electronic waste' is used in the legislation to cover any appliance or device which is powered by electricity or battery, and therefore includes large electrical white goods as well as smaller electronic items. Trade Association noted that they have proposed that this category be split into large household appliances[21], small household

[20] Accessed on 22nd August 2015

[21] Washing machines, dryers, refrigerators, air-conditioners etc.

appliances[22] and office, information and communication technology[23]. The current classification is too broad and constrains the creation of new policies and waste plans. Such a broad classification also does not take into account the complex nature of mobile phone technology and was noted by City Council and Government Adviser as a constraint to the improvement of recycling policy, particularly as regards refurbishing components and reusing materials.

Consultant, Trade Association and NGO were clear that the lack of government support to business, particularly technology entrepreneurs (for repair, reuse and beneficiation[24]) was a severe constraint. Two examples were given by Trade Association. Firstly the awarding of licences for small recycling operations can take a year and no activity can start until the registration process is complete. Secondly the government does not provide funding to small recyclers nor training for operating to quality standards.

Manufacturers were considered by Recycler and Trade Association as the actor responsible for managing e-waste but not currently being held to account by government. Manufacturer, on the other hand, did not think that government fully appreciated the complexity of e-waste management which required integrated thinking on a global scale to maximise the benefits to SA economy and society.

City Council proposed that the lack of consistent separation of waste at source across the country[25] was encouraging the disposal of e-waste to landfill with the result that informal street pickers sort through bins to find waste that they can sell to recyclers. This practice is commonplace in SA even though it is contrary to council regulations and open to abuse by recyclers.

In fact, the lack of political co-ordination with stakeholder groups also emerged in the way that City Council operated: for example silo working was evident in operational departments. Furthermore some national and provincial regulations do not have supporting guidelines and therefore require individual interpretation. City Council went further to assert that the public sector is not always leading by example in respect of waste management practices. For example a 4bn Rand public sector tender to provide mobile phones had been awarded but no provision was made for recycling at the end of the four year contract. Consultant suggested that SA lacked a 'roadmap' towards CE which would provide guidance on how the ideas could be implemented.

In comparison with other countries, the lack of an enabling environment for recycling is also a recurring issue in Ghana, India, and China with little funding and training initiatives for small businesses. Indeed the lack of recycling infrastructure in China and India has restricted the growth of entrepreneurs to repair mobile phones. The political environment in SA is complex and there is a lack of pilot CE projects in SA. China is in a similar position and so the eco-city of Dalian could provide a business case for CE in SA. The complexity of the political environment in China hinders recycling initiatives and, like SA, does not provide funding and training to small e-waste recyclers to run their operations to acceptable standards.

[22] Vacuum cleaners, coffee machines, irons, toasters etc.
[23] PCs, laptops, mobile phones, telephones, fax machines, copiers, printers etc.
[24] Beneficiation is used in the context of CE as the upgrading of quality through extraction of valuable materials and rework into refurbished products. The technology required to achieve this can be very expensive and from a CE perspective is generally undertaken outside the national borders of a country in the Global South.
[25] Some metropolitan areas were now providing recycling bins to householders but the process was slow and did not include commercial premises.

5.2 Economic Constraints

The lack of secure, supervised collection points and take-back schemes within South Africa was mentioned by all interviewees. NGO and Network Operator proposed that overcoming this constraint can make the investment in environmentally-friendly recycling technology economically viable as seen by the partnership between MTN (SA network operator) and GIZ in Germany. Trade Association emphasised that this was partly related to the lack of financial incentives to encourage consumers to return old phones for recycling and, according to their research, this occurred even in the poorest of townships in SA. Network Operator, NGO and Trade Association all maintained that the patterns of consumer behaviour result in low return rates as passing handsets onto family and friends is a greater driver than financial incentives. However, Trade Association underlined that there is inherent competition between Manufacturer's take-back schemes and Recycler who makes money by sending expired phones to China and India for material retrieval.

NGO proposed that the informal economy doesn't have access to working capital to buy spare parts for repair activity. Consultant suggested that, as globally raw materials are not yet scarce and prices were still relatively low, there was no incentive for Manufacturer to invest in expensive remanufacturing technology despite ambitions in SA for the Western Cape Province to become a regional manufacturing hub in Southern Africa. Trade Association proposed that this will change when China's monopoly on rare earths drives up prices to make CE economically viable.

Manufacturer emphasised the economic and competitive drivers in the mobile phone industry: only Apple and Samsung are profitable and so any move towards CE would need redesign[26] costs to be less than economic benefits from repair and resale. Trade Association asserted that as phone manufacturers and network operators focus on the creation of profits and minimising the cost of meeting e-waste regulations, they aim to sell consumers new phones with upgraded technology and design. This strategy generates higher profits than from the sale of refurbished second hand phones but does not give consideration to the longer-term environmental impact.

Furthermore, City Council argued that, due to economic constraints, technology for CE processes does not exist within SA, even on a pilot basis. This means that product redesign, value creation from e-waste and beneficiation takes place outside SA. Manufacturer highlighted similar economic constraints in providing pre-financing for the establishment of small-scale recycling. Similarly, the scale required to justify investment in treatment facilities to recover valuable materials was not yet economically sufficient.[27] Manufacturer also referred to the relatively small scale of the current CE activity for mobile phones in SA which means that there is little incentive for further investment by Manufacturer in the redesign of phones for them to be more easily repaired and upgraded.

Trade Association, Network Operator, Manufacturer and Recycler underlined the tensions that exist between actors from the lack of a common vision for the long-term future of the mobile phone industry. Consultant brought this point out clearly by saying that there is no commonly-agreed business case for CE currently being proposed in SA. Without both private sector and government backing, Consultant thought that CE would be very difficult to achieve.

[26] Fairphone (www.fairphone.com) and Phonebloks (www.phonebloks.com) are two examples of modular mobile phones which eliminate built-in obsolescence in current designs and allow owners to upgrade or repair; they are not yet available globally due to high costs of development and moving to scale.
[27] State-of-the-art e-waste treatment facilities managed by Umicore in Belgium cost 10m Euros to build (www.umicore.com/en/industries/recycling)

NGO was the only stakeholder to clarify the part that the informal economy had to play in repairing handsets and the barriers to accessing finance for working capital in their operations. In India, China and West Africa, the informal economy has an important role to play in the collection of old phones for resale or refurbishment. The informal economy in SA, by contrast, focusses on the recycling of general waste, rather than e-waste, where there is a higher cash value to be realised. Job creation in the 'green' sector is a key priority for public bodies in SA through measures such as the formalisation of the work of informal workers. The informal economy in China and India is seen as key to future economic growth and needs to be encouraged through entrepreneurial initiatives.

5.3 Social Constraints

Privacy was proposed as a major concern of consumers by Academic, Government Adviser, NGO and Trade Association. The lack of a trusted Manufacturer take-back scheme with a confidential mechanism for wiping personal data from end-of-use phones is a key barrier to users returning handsets for recycling. Government Adviser argued that under existing SA law, privacy of personal information would be a key requirement for take-back schemes.

Consultant, Network Operator and the NGO were conscious of the behavioural aspects of mobile phone use e.g. keeping old phones in drawers at home or passing them onto friends and family. Consultant spoke of the trend of upgrading phones mid-contract to access the latest models and that this is a constraint which crossed socio-economic groups[28]. This has resulted in return rates of less than 10%. A further example of behaviour change was evidenced by NGO and Recycler: manufacturers need to accept responsibility for disposal of e-waste through the implementation and enforcement of EPR in SA under NEMWA[29] regulations.

Consultant suggested that consumers and Manufacturer are still in an 'ownership' mindset whereas CE thinking proposes a 'service performance' approach. For mobile phones this would require consumers to pay Manufacturer and Network Operator for the 'use' of the phone for a fixed period and a contractual return and replacement allowing recycling to take place more effectively. Consultant argued that to achieve this, more collaborative and resource-sharing mindsets were required, as has been successfully managed globally by Airbnb (accommodation) and Uber (taxis).

NGO was the only stakeholder to emphasise a beneficial outcome of the informal economy becoming more involved in CE activities but this is held back by the lack of identity papers and the low level of income declared. Based on the experience of other countries such as India, the development towards CE in SA would include informal workers and their role in e-waste collection.

Similar cultural constraints to recycling in SA were found in India where repair is not always seen as an option by consumers and in Finland where the majority of people store old phones in their homes. In SA there has been a lack of official support in the form of training and technology to improve skills and eliminate unsafe practices. This has also been the case in both China and India where the informal sector has now become part of recycling practice.

5.4 Technological Constraints

[28] Trade Association noted that in some cases these upgrades were achieved at the expense of 'essential' expenditure such as transport and education.
[29] NEMWA = National Environmental Management: Waste Act, 2008, South Africa.

Academic, Consultant and Government Adviser touched on the subject of mobile phones not being 'built to last' i.e. the inability to replace batteries and repair failed components means that replacement phones were bought instead and recycling options were limited. Manufacturer, by contrast, emphasised the complexity of the structure of mobile phones meaning that CE would be very difficult to achieve on a single country basis without sufficient resources and technology being available locally. Furthermore NGO argued that mobile phones are designed in the USA and Europe at standards which are not always appropriate for developing countries.

Academic, Consultant and Government Adviser highlighted the lack of technical capability in SA to take benefit from beneficiation in-country and the lack of alternatives to non-renewable resources. They went further to highlight there is insufficient capability to fully treat e-waste locally, meaning value-added processes are located outside SA. Consultant and Recycler highlighted the consequences of current methods of recycling being relatively low-tech with manual separation of parts followed by dispatch to China and Europe for treatment.

Whilst emphasis was made in the interviews of the complex nature of mobile phones, no interviewee mentioned the technological constraint of the incompatibility of mobile phone chargers. If this could be achieved in SA it would be one means of reducing e-waste. This issue is now being addressed in the EU but, as emphasised in literature on USA, mobile phones are not designed to be repaired or second hand parts used to replace ones that have failed.

5.5 Legal Constraints

City Council and Government Adviser argued that some parts of the SA waste legislation make interpretation and application difficult due to many recycling processes mentioned for each type of waste. Consultant, Government Adviser, NGO and Trade Association all highlighted that such complex waste legislation in SA and the lack of guidance on interpretation combine to cause a lack of enforcement resulting in low standards in recycling operations. This has an impact on the Recycler in the form of high costs of establishing and running a formally registered recycling operation meeting quality standards.

A degree of confusion existed over EPR mentioned by NGO and Trade Association. The former suggested that there was no legislation in SA to cover EPR whereas the latter believed that there was legislation but it wasn't enforced correctly. This lack of clarity has resulted in manufacturers not being fully conversant with legal requirements. With SA government not enforcing the existing law, this has resulted in manufacturers not playing their full part in establishing recycling initiatives. Trade Association mentioned very recent government requirements for waste management plans in the electrical and electronic, paper, packaging and lighting sectors.

However, NGO suggested that developing countries do not have as much capacity and ability to implement and enforce legislation as developed countries and lessons need to be learnt from other countries. City Council had recently started an EU-funded collaboration with the City of Florence so that lessons could be learnt and applied in SA.

In the research interviews legal constraints in SA were mentioned frequently. This reflected the government's concern about the safe disposal of e-waste and the need for careful handling of hazardous materials. Similarly in the literature review, one constraint in developing countries was whether EU-type legislation could be replicated in their own contexts which has not always been an effective means of forcing responsibility for ultimate disposal onto the original manufacturer.

5.6 Environmental Constraints

Whilst national waste plans exist, Recycler and Consultant observed that the lack of local waste plans was holding back the capability of SA to handle e-waste efficiently. Consultant and NGO proposed that this resulted in poor awareness of mobile phones as hazardous waste, an example of which came from one interviewee who admitted putting a broken mobile phone into a domestic landfill bin.

Academic emphasised the lack of domestic waste separation of recyclable waste from landfill waste although this was starting in some metropolitan areas. Consultant proposed that, as landfill space was at a premium, an entrepreneur with funding might come forward to provide innovative solutions to the handling of e-waste. However, Trade Association disagreed with this and emphasised that responsibility should be enforced on Manufacturer through national legislation and local regulations.

Consultant underlined that non-environmentally friendly design of mobile phones was an important constraint to recycling in SA. Trade Association pointed out that a university in SA was undertaking research on replacement materials and the recovery of copper in e-waste which would assist in the reduction of use of virgin resources.

Experience of constraints from other parts of the world focussed on the tension that exists between continuing economic growth and the environmental impacts to achieve this, as is currently being experienced in China. In India and West Africa the lack of formality in e-waste disposal has had an adverse impact on the environment, particularly the release of toxic materials through inappropriate disposal of e-waste into landfill. SA is only just seeing the start of these issues and the lack of a co-ordinated waste plans across the country is a constraint to resolving this.

5.7 Implications of Constraints in SA

The **Political** environment in SA requires a greater degree of co-ordination on policy as well as a broader understanding of the complexities of e-waste disposal, particularly in the need to separate electronic from electrical waste. To implement CE thinking a form of a 'roadmap' will be required which builds on experience from other countries.

The relatively large number of **Economic** constraints mentioned by interviewees highlighted the importance of collaboration between the private sector, NGOs, government and consumers if CE in SA is going to gather any form of momentum. Investment in treatment and recycling technology will only be economically viable if informal and formal stakeholders find ways of working which satisfy private sector return on investment objectives at the same time as minimising negative environmental and social impacts.

Whilst individual **Social** constraints were fewer than Economic, stakeholders were keen to emphasise that behavioural barriers are the biggest challenge. Financial incentives will be required for consumers to return handsets rather than regulations; however these are likely to decrease manufacturers' profitability through EPR mechanisms. Furthermore City Council and other employers need to include the informal economy (as collectors of e-waste) as part of the value chain with the formal economy (as recyclers of e-waste).

Similar **Technological** constraints were mentioned by several stakeholder groups. The current design of mobile phones did not make them easy to repair and CE thinking requires a more modular approach on a global scale which would take many years to become a reality. Also the technology required for recycling in SA to move beyond low-tech solutions and create

beneficiation businesses in-country is expensive and would require investment by the private sector along with incentives from government.

The capacity of developing countries to draft, implement and enforce complex e-waste legislation is considered a severe **Legal** constraint and help would be needed from other countries e.g. EU which has experience to share. This was essential where EPR was a key component and manufacturers are not sufficiently engaged in the process.

Environmental constraints centred on planning and design. Local waste plans are needed to increase public awareness of the hazardous nature of mobile phones and to encourage greater recycling. Also mobile phones are designed in developed countries and do not take account of the need to easily repair and reuse.

Finally, constraints not mentioned in the interviews included those which are internal to a business such as organisational culture, environmental awareness or strategic decision making. These constraints can potentially inhibit companies considering CE thinking where directors have concerns that such methodology would result in profit reductions, even before any financial analysis is undertaken. In addition, little mention was made of the role that the informal economy has to be play in CE. In contrast, a joint approach has been used in India where informal workers focus on collection while formal businesses are involved in treatment of e-waste.

Chapter 6 - Overcoming constraints

The literature review and interviews were focussed on the constraints to the recycling of mobile phones in South Africa. Constraints are time and context specific: laws, policies, infrastructures, behaviours and technologies change which can result in the constraints being eliminated over time.

Some possible solutions to the creation of CE in SA are mentioned in this chapter. One solution has been included for each of the PESTLE categories as well as one overarching solution.

6.1 Political

Peer learning could provide a method of gaining the knowledge required to overcome political constraints. Johannesburg Metropolitan City Council is partnering with the Italian City of Florence to learn from their experience of waste management. At the end of this project in two years time, the learning will be shared with all City Councils in SA. One outcome might be that ‘green’ initiatives are established in order to create jobs, including moving people involved in waste collection from informal to more formal employment through participation in co-operatives.

6.2 Economic

Recycling requires behaviour change by businesses and consumers. Take-back schemes have proved successful in increasing return rates in a number of countries, particularly USA. In 2015, a major UK retailer, Argos, has partnered with a government-sponsored consultancy, WRAP, to create a take-back and disposal scheme for mobile phones & tablets with on-the-spot quotations and credit given via gift voucher (Brignall, 2015). This scheme uses reverse logistics for the return of devices to the centre by lorries which have delivered new product to the store. It provides financial incentives for consumers and a source of profit to Argos from the sale of refurbished phones. This approach could be piloted by a major SA electronics retailer, such as Makro, to test the response to such a take-back scheme.

6.3 Social

Poverty can be reduced through the creation of formal employment for people currently working in the informal economy. SA's capability of recycling mobile phones is constrained by not involving informal workers sufficiently in the process with other stakeholders. In Ghana, a charity called Closing the Loop buys 'end-of-life' mobile phones and recycles them in a responsible way; they achieve this through collaboration between the formal and informal economies: collectors, scrap dealers, repair shops, manufacturers, operators, NGO's, and smelters to extract 95% of metals such as gold, silver and palladium (Closing the Loop, 2015).

6.4 Technological

Mobile phone technology provides educational and financial benefits to SA and technology can be a means of overcoming constraints. For example, one of the key inhibitors to the recycling of phones in SA is the low return rate of expired devices which is partly caused by challenges in safeguarding the privacy of personal data stored on mobile phones e.g. names, addresses, personal messages, and passwords. Apple in the USA and Argos in the UK have devised sound technical methods of wiping personal data from handsets returned to them for recycling.

6.5 Legal

Legislation for the environmentally-friendly and safe management of e-waste has been implemented in a number of countries e.g. China and EU. EPR was the basis for WEEE legislation in the EU. Successful implementation of EPR regulations has seen car manufacturers taking responsibility for final disposal under the 'End of Life Vehicles" regulations (Gov.uk, 2015). Manufacturers negotiate with scrap dealers to take cars for dismantling and recycling with no cost to the final owner. As a result longer-term hire contracts are becoming more popular. For mobile phones this model could be utilised e.g. a 2 year contract with the phone given back at the end and another one provided with no intermediate upgrades.

6.6 Environmental

The hierarchy of waste theory in SA comprises: reduce, re-use, recycle, recover and dispose (Interwaste, 2015). An example of a partial CE model in SA is REDISA, a government-supported waste tyre recycling company. Since it started in 2012 it has increased recycling rates from 4% to 19% and stopped more than 125,000 tonnes of used tyres going to landfill by creating innovative forms of collection and recycling. REDISA is now supporting 190 small and medium-sized businesses and has created 2,505 new jobs nationally (Perella, 2015). The approach is based on EPR through a levy based on the weight of tyres manufactured in or imported into SA. These funds are then used to build waste recovery infrastructure and support research and innovation. A similar resource extraction tax is being considered in SA to reduce the use of virgin materials in mobile phones making recycling potentially more economically viable[30].

6.7 Overarching

The above possible solutions relate primarily to the improvement of recycling mobile phones. Yet in SA there does not appear to be a co-ordinated approach to the development and implementation of CE. Initiatives are underway in SA which move towards such a framework but they are not yet integrated into national policy. For example the Western Cape Industrial

[30] A comment from one of the Trade Associations interviewed in South Africa.

Symbiosis Programme (WISP) where the waste from one business is shared with another business who can use this as input for its own operations.

Amongst other emerging economies, China has developed legislation based on the principles of circularity but has not yet fully implemented them compared to other countries. In its twelfth national five-year plan (2011-2016) the government has stated that it will, *"Plan, construct and renovate various kinds of industrial parks according to the requirements of the circular economy"* (Qimin, 2015).

Amongst developed nations the EU is currently in the process of creating a CE Strategy[31]. The main policy objective is to create conditions for the development of CE by overcoming barriers and enabling the development of new markets and business models, creating jobs, avoiding pollution and waste, and slowing down the depletion of key resources.

In parallel, Scotland launched a consultation process in August 2015 aimed at creating a fully-fledged CE for the country. The Resource Association, the trade association for the recycling industries in the UK, proposed that, "This is now a "golden opportunity" to put quality recycling at the heart of a circular economy" (Edie.net. 2015).

The South African government could consider the construction of a national CE manifesto or roadmap which would bring together representatives from stakeholder groups to co-ordinate action and use evidence from around the world of how to develop and implement CE.

Chapter 7 – Conclusion

The current Linear Economy for mobile phones in SA could be characterised as, *"Designed in the USA, made in China, used in Europe, disposed in landfill or by incineration."* If SA moves towards CE it could be characterised as, *"Designed in the USA, made in China, used in Europe, reused in Nigeria, disassembled in South Africa, material extracted in Taiwan, material sold in global markets, and loops closed wherever possible; and only when there is no more use for any remaining part, the residue, disposed of responsibly."*[32]

This quote captures the journey involved in moving towards CE. This research paper concentrates on one step in this journey. It seeks to identify the constraints that SA is experiencing in recycling mobile phones. It draws on published academic literature and other secondary sources of information to identify constraints experienced in other countries with recycling e-waste. The amount of published writing on the recycling of mobile phones is relatively small and so extended primary research via semi-structured interviews was carried out with representatives from key stakeholder groups in SA and Europe. Finally some example solutions to the overcoming of constraints to recycling mobile phones are proposed in the context of SA.

The literature review looks at the experience of constraints in China, India, Ghana, Brazil, Finland, Switzerland, Denmark, UK and EU. Some governments have the capacity to develop CE and e-waste legislation (EU and China) as well as develop pilot cities to test implementation (China). The informal sector is often considered an important part of e-waste recycling, yet some countries

[31] In September 2015 a stakeholder consultation meeting has been convened in Belgium to consider the issues involved in drafting the necessary legislation (EU CE Strategy Roadmap, 2015)
[32] This characterisation was developed by the author during the course of the research for this paper.

were more advanced in including them (China and Ghana). However, there was very little literature on the specific topic of recycling mobile phones in South Africa.

A series of interviews with representatives from stakeholder groups was undertaken in SA. The constraints were wide-ranging and highlighted the global value chain of mobile phone design, manufacture, use and disposal processes. As found elsewhere in the world, the need for a co-ordinated effort by government, regulators, manufacturers, network operators, retailers and consumers is required to ensure that constraints to recycling are identified and strategies developed to overcome them.

During the course of the research a number of solutions were identified. The ones mentioned in this paper are only examples of what is possible. The key theme running through these solutions is the need for recognition of the complexity of designing, manufacturing, and recycling mobile phones and the extent of the global value chains that result. The constraints identified from primary and secondary sources and an example of a possible solution are summarised in Table 2 Below. This table contains the core of the research.

Table 2 - Summary of findings from literature review, research interviews and example solutions.

Constraint Category	Secondary Sources (Literature)	Primary Sources (Interviews)	Example Solution
Political	•Lack of enabling environment and incentives •Poor implementation of policy •Manufacturer bearing the cost of disposal •Lack of recycling infrastructure •Informal sector not encouraged to engage with formal systems •Lack of co-ordinated national waste strategy	•Definition of e-waste includes both electric and electronic •Lack of government support to formal and informal businesses involved in recycling •Manufacturers not being held to account for disposal costs •E-waste management is complex process •No separation of recyclable materials in domestic waste collection •Silo working in government departments	*SA metropolitan city council partnering with European city to share learning of implementing recycling initiatives.*
Economic	•Poor return rate of phones for recycling •Lack of formal recycling schemes •Insufficient financial support from banks and other funders •Landfill is still a cheap option for disposal •Few incentives to develop CE initiatives	•Lack of economically viable take-back schemes •Few financial incentives for consumers to return end-of-life devices •Informal economy does not have access to funding for parts •Raw material prices still too low to encourage reclaiming •Manufacturers focus on profit from selling new rather than second hand phones •No current business case for investing in CE technologies •Informal economy not involved in collection and e-waste recycling	*Take-back scheme established in UK through collaboration between retailer and environmental consultancy*

Constraint Category	Secondary Sources (Literature)	Primary Sources (Interviews)	Example Solution
Social	•Repair not seen as a viable option by consumers •Culture of retaining handsets in drawers •Collection systems not placed in convenient locations •Informal sector not suitably skilled to handle e-waste	•Lack of trusted take-back scheme re personal privacy •End-of-use devices kept in drawers not available for recycling •Manufacturers not accepting EPR •Consumers still in ownership mindset rather than 'use' •Informal workers reluctant to register to participate in activities	*Informal sector working with other stakeholders to collect and process disposal of mobile phones in Ghana*
Technological	•Mobile phones not designed to be repaired •Treatment of hazardous waste in limited locations •Lack of data on waste limits strategic planning •No government support for equipping informal sector with appropriate technology •Incompatibility of phone chargers	•Mobile phones not built to last and barriers to repair •Complexity of components hinders full recycling in SA •Lack of technical capability in SA for beneficiation work •Low tech approach to recycling missing out of higher value	*Creation of secure process to wipe confidential personal data from devices which have been returned under take-back schemes*
Legal	•Non-transferability of Western models to developing countries •Manufacturers resisted EPR legislation •Illegal importation of e-waste limited options for improving standards of recycling •No co-ordinated legislation for e-waste management	•Some of waste legislation is complex and lacks guidance on interpretation •Confusion over whether EPR legislation is enforceable •Lack of capability to draft and enforce e-waste regulations	*EPR legislation has been successfully implemented in EU under the WEEE directive*
Environmental	•Poor control over informal workers polluting land with toxic materials •Air pollution from industrial processes limiting options	•Lack of local waste plans reduce efficiency of handling •Little separation of domestic recyclable waste •Phone design is non-environmentally friendly •No man-made alternatives to virgin raw materials in phone	*Lessons learnt from REDISA, tyre recycling initiative in SA, applied to mobile phone recycling*

This study will be of interest to business leaders and investors as more companies consider the possibility of investing in recycling technology. From the perspective of the creation of the wider CE, business will also find this research helpful in considering how strong are the forces from consumers to purchase phones which are modular in design with parts able to be replaced rather than simply sent for recycling. Manufacturers also have a role to play in facilitating retailers and network operators to launch 'take-back' schemes to overcome the constraint of low return rates by consumers. Policy makers will also be interested to evaluate the experience of regulation in other countries and lessons that can be learnt by SA.

One route to overcoming of constraints to recycling mobile phones in SA is the creation of a broader CE manifesto or roadmap, perhaps on a regional basis, as currently being considered in the EU. This might enable Southern Africa to leapfrog into CE on a scalable basis and pave the way for the rest of Africa. A focus of possible future research is an evaluation of the EU CE consultation

process and its subsequent impact on e-waste creation and resource utilisation. The lessons learnt can then be considered in the context of SA and neighbouring countries so that more effective progress could be made towards the creation of CE in SA, even if some of the phases of circularity are undertaken outside national and regional boundaries. The role of the informal sector will need to be an additional component for SA as it may not be covered in sufficient detail in the EU roadmap.

This research identifies the constraints that currently exist in SA to recycling mobile phones as well as the experience of other countries. These constraints can be overcome through changes to legislation, policy, infrastructure, financial incentives and consumer behaviour which would require all key stakeholders in collaboration participating in a globalised economy to recover valuable resources and reduce waste.

Appendix I – Questions Asked in Research Interviews

The primary question asked in the research interviews was, *"What do you think are the constraints to the recycling of mobile phones in South Africa?"* Supplementary questions were then asked depending upon the experience and knowledge of the person(s) being interviewed as well as how they answered the first question. Examples of these supplementary questions are listed below by stakeholder group.

Mobile phone manufacturers

- If based in the EU, do you comply with the WEEE directive? If yes, in what ways has this benefitted your business? If no, what are the constraints in compliance?
- What constraints do you see for a system of creating a closed-loop system of mobile phone manufacture which did not harm the environment nor the people involved in the process?

Consumers[33]

- What are your key concerns when buying a new mobile phone or upgrading?
- What factors would you take into consideration if you could buy or upgrade to a phone which guaranteed a final disposal option which did not harm the environment nor the people involved in the disposal process?
- What factors make you choose a brand of mobile phones? To what extent do design, price, functionality, and community involvement by the manufacturer?

City Council Managers

- Does the City Council provide a facility for the disposal of mobile phones? If yes, how does the process work? If not, what are the difficulties in providing such a facility?
- Does the City Council utilise the services of any informal businesses as part of this process?

Civil Society

- What are your key concerns in respect of the handling of e-waste, particularly the ultimate disposal of mobile phones which are no longer usable?
- What have you found to be the most effective way of encouraging consumers, business, and governments to change their behaviour in relation to the disposal of mobile phones which are no longer usable?

National Government

- What policies are in place for the ultimate disposal of mobile phones which are no longer usable?
- Have you signed up to any global regulations for the disposal of mobile phone waste?

Waste Disposal Operators

- Who are your major customers and what are the key requirements that each require in the contract you have with them?
- Do you contract with any suppliers which might be considered 'informal' businesses and what are the key requirements that are included in the contract that you have with them?

Academia

- Are you currently researching any element of mobile phone value chains?
- Has this generated any interest from the mobile phone manufacturer community?

[33] A number of interviewees in other participant categories also answered from the perspective of also being consumers themselves.

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