

A framework for the re-use, recycling and disposal of waste electrical and electronic equipment: The South African case

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ABSTRACT

In this thesis, A framework for the re-use, recycling and disposal of waste electrical and electronic equipment: The South African case, the researcher did an investigation on current practices in South Africa dealing with e-waste from the household sector in urban areas. E-waste is all electrical and electronic equipment that has come to the end of their life, and it is the fastest growing waste stream globally. The concern related to e-waste is that toxic elements are released if the waste end up in landfills or is exposed to the elements of nature. In South Africa around 360 000 tons of e-waste is generated yearly of which only 10 to 15% is recycled. No model exists for South Africa to deal with the e-waste problem and the researcher took on the study to address the issue. A mixed methods study was conducted in which a survey was conducted amongst 522 South African consumers and 20 industry stakeholders were interviewed. The study amongst consumers revealed that convenience, a positive attitude towards e-waste recycling, and environmental awareness were the biggest contributors to recycle e-waste. The biggest drivers to achieve success are however not supported, and through the research, solutions could be identified and proposals were made to address the shortcomings. The interviews revealed how the problem can be addressed from the point where electronic devices enter the borders up to the disposal stage. A framework has been developed during the study which will address financial aspects, collection initiatives, transportation, new recycling facility setup, and the overall management of the whole process. The study revealed that the South African Government must introduce dedicated e-waste legislation, but the management of the system must be done by a Producer Responsibility Organisation (PRO) which involves different stakeholders. The stakeholders will ensure there is transparency and a corruption free system. It is the wish of the researcher that Government seriously consider the proposals captured in the framework before South Africa drowns in e-waste.

KEYWORDS

Environmental awareness, WEEE, e-waste, recycling, TPB, producer responsibility organisation (PRO), extended producer responsibility (EPR), environmental awareness, attitude, personal convenience, advanced recycling fee, auction house, e-waste collection, and e-waste transportation.

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CHAPTER 1: INTRODUCTORY CHAPTER

1.1 INTRODUCTION

In this chapter, an outline of the current study is presented. The chapter commences by offering a brief background to the study, the research problem, research aim, and objectives of the study. This is followed by an explanation of the research design and methodology as guided by an illustrative framework. The contribution and imitations of the study are then considered. The key terms of the study are presented. The chapter concludes with a research outline of the content of the study chapter-by-chapter.

The aim of the study is to suggest a framework for the re-use, recycling and disposal of waste electrical and electronic equipment (WEEE) in South Africa. To provide a comprehensive and complete understanding of the phenomena of e-waste in South Africa, from the perspective of key stakeholders and consumers, a convergent parallel design mixed method design was applied.

1.2 BACKGROUND

From involvement in a project that investigated the possible recycling of cellular phones and cellular equipment, the researcher became aware of a problem facing South Africa. The investigation highlighted the extreme toxic nature of waste electrical and electronic equipment (WEEE or e-waste), if not treated safely. Initial investigations revealed that friends and family do not know how to dispose of domestic WEEE, which prompted the researcher to investigate the South African e-waste environment.

1.2.1 The significance of managing e-waste effectively

Widmer *et al.* (2005:438) refer to electrical and electronic equipment (EEE) as all devices that are electrically or battery operated. Although there is no standard definition, the terms WEEE or e-waste are a generic terms for electronic or electrical waste. It includes all forms of EEE that have ceased to be of any value to their owners and can easily end up in landfills and open areas where there is no control over the discarded equipment.

E-waste contains toxic materials and has become a serious challenge due to the volumes being generated around the globe (Garlapati, 2016:877). A contributing factor to the ever-increasing volumes of e-waste is the rapid depreciation of EEE products as well as the deliberately curtailed product lifespan of electronic devices (Echegaray, 2016:191).

The burning of e-waste to retrieve valuable materials cause air pollution, and inhalation or contact with some of these elements can lead to serious illnesses or even result in death (Eren, 2014); some hazardous substances in e-waste are known human carcinogens causing cancer and possibly deaths. If humans are exposed to these elements it can cause allergic reactions, asthmatic bronchitis, abdominal cramps, vomiting, nausea, diarrhoea, DNA damage, irregular heart rhythm, a reduced production of red and white blood cells, blood pressure problems, breathing problems, numbness of the face, weakness of muscles and paralysis in humans, to mention some (Ejiogu, 2013:202-203). Chlorofluorocarbons used in refrigeration equipment causes depletion of the stratospheric ozone and due to the greenhouse effect, contributes to global warming (Tsai, 2014:883).

According to a United Nations report, an estimated 50 million tonnes of electronic waste, or e-waste, is discarded around the globe every year. This is more than the total weight of all the commercial airliners ever made (UN NEWS, 2019). In South Africa, 90% of general produced waste ends up in landfills, while only 5.2% of households participate in recycling (Stats SA, 2018). It is estimated that on average, a person in South Africa generates around 6.2 kg of e-waste annually. These figures correlate with the Department of Environmental Affairs who estimated the national generated e-waste to be around 360 000 tons per year (Mhlanga, 2018). This implies that 324 000 tons of e-waste is not recycled every year, even if a high 10% recycling rate is assumed. E-waste is thus stored, dumped in refuse bins, disposed at landfills and garden refuse sites, or informally recycled. Except for storage, the other methods of disposal can have negative effects on the environment, and the health of animals and humans.

Although e-waste contains toxic elements, there are business opportunities as valuable materials can be extracted from the waste. General e-waste fractions contain gold, copper, aluminium, iron, and other metals (Garlapati, 2016:877; Widmer *et al.*, 2005:436). Businesses focus typically on e-waste recycling areas offering sustainable financial

benefits, and steer away from areas that are unsustainable. A few recycling facilities do exist in South Africa, but they mainly focus on electronic boards recycling, as this is where the most valuable fractions can be extracted. PC board fractions are exported to refineries for smelting and extraction of valuable material, while the dismantled fractions are sold locally and internationally (Desco, 2019; Finlay & Liechti, 2008:32). Roughly 80% of plastic and 90% of printed circuit boards recovered from e-waste in South Africa are exported for reprocessing. This is due to South Africa not having the technology to handle such large scale processing. Some E-waste is also exported illegally to countries such as India or China (Naidoo, 2017).

Switzerland has been a pioneer in European countries, where voluntary initiatives started formal collection and management of e-waste even before legislation came into place (Khetriwal, Kraeuchi & Widmer, 2009:159). A review of the European Union (EU) and Japan's recycling of domestic e-waste indicated relatively high success rates with 5.9 and 2.8 million tonnes respectively being recovered per year. The United States of America and China produces 5.7 and 4.1 million tonnes respectively of domestic e-waste ending up in landfills, incineration or storage (Garlapati, 2016:877).

By purely considering these e-waste recovery figures, the assumption can be made that if all countries adopt the same methods as Switzerland, the EU or Japan, the e-waste problem would be solved around the world. This preposition is a total oversimplification, as different countries have different cultures, attitudes, social problems and behaviours. Furthermore, economic drivers, financial means, infrastructures, and incentives are factors that can either hinder or contribute to an e-waste recycling system. The success of a system in some developed countries does not guarantee success in other developing countries (Borthakur & Govind, 2018:1056; Kahhat *et al.*, 2008:958).

South Africa does not have any dedicated e-waste laws and to get clarity on e-waste issues a variety of health and safety as well as environmental laws must be analysed. It is difficult to get clarity on e-waste matters as the general legislation on waste can be differently interpreted; this is a strenuous and inadequate situation (Dittke, 2009:6). This uncertainty allows for differences in strictness and enforcement of waste removal between municipalities and provinces.

The result is a general lack of awareness regarding the hazardous nature and dangers associated with e-waste from the public and, to an extent, the authorities (Dittke, 2009:48).

In South Africa, no formal system exists for e-waste management focusing on household e-waste, and products are mainly imported (Workman, 2019). Many of the originating countries, such as the European Union (EU) and Japan, have e-waste management programmes in place but the lessons learnt have not been transferred to South Africa. A lack of a proper e-waste management system in a country causes poor performance, which is also evident in South Africa. Research is needed to determine which measures are needed to address the problem of domestic appliance recycling effectively. From the results obtained, a proposed framework will be developed for South Africa, which will address the e-waste management system. The aim is to develop a compliance system to provide South African stakeholders with clear direction. Without a compliance system, e-waste will just pile up in homes, be disposed in landfills, and humans and the environment will be negatively affected.

1.2.2 Key mechanisms to co-ordinate and drive the e-waste management processes globally

Countries around the globe have varying successes in recycling e-waste. From an early stage, Switzerland introduced measures to recycle e-waste, even before legislation came into effect (Fredholm, 2008:24). The e-waste problem is uniquely addressed around the globe with mechanisms that are country specific. These include legislation, collection arrangements, financial measures, compliance systems, and the involvement of stakeholders. This study is important as the mechanisms that will be the best fit for effective e-waste recycling in South Africa needs to be explored.

- ***Extended Producer Responsibility (EPR) and product stewardship (PS)***

Two major strategies can be employed to manage end of life (EoL) equipment effectively. They are extended producer responsibility (EPR) and product stewardship (Nicol & Thompson, 2007:227).

- ***Stakeholder responsibility***

Around the globe responsibilities of stakeholders differ. In Japanese law, the specific roles of stakeholders are clearly specified. Consumers are responsible for paying for recycling at the time of disposal, retailers must collect items from consumers and transfer them to manufacturers, and manufacturers (including importers) must recycle the items (Aizawa, Yoshida & Sakai, 2008:1399). In Taiwan, residents are responsible for taking their waste to municipal collection points where it is separated, collectors and recyclers then buy e-waste from residents; local governments collect e-waste from community collection sites, and a recycling fund subsidises the collection of municipal e-waste and that of private collectors and recyclers (U.S. EPA, 2012:7). In South Korea, the recycling funds are deposited into a government account and are payable by manufacturers. Local manufacturers and importers can institute their own recycling facilities or else it can be outsourced to professional recycling companies or to industry associations (Kahhat *et al.*, 2008:957). Responsibility roles differ around the globe and the South African stakeholders' responsibilities needs to be investigated.

- ***Systems coverage and ensuring compliance***

In the European member states, two types of compliance categories for private household WEEE applies. A competing collective system applies if more than one compliance scheme is handling the same category WEEE, thus resulting in competition. A single national compliance system applies if there is no competition and one-system deals with all WEEE categories (Sander *et al.*, 2007:97).

- ***Registry of E-waste***

A registry is a method of keeping track of what is placed on the market, and from where the products originate.

- ***E-waste legislation around the globe***

Legislation involving e-waste differs around the globe. European countries have directives guiding the process (Manomaivibool & Hong, 2014:203). While certain developing countries have some form of legislation, e-waste is still exported from the United States of America (USA) to countries where there are less health and environmental safety laws (Puckett, 2016).

- ***Collection arrangements of e-waste***

In Europe the collection is done by the distributor of products, producers, municipal collections, and public collection points (Sander *et al.*, 2007:III). In China the practice is mainly to sell e-waste to informal recyclers (Orlins & Guan, 2016:75-77), while In Denmark, small WEEE, light sources and portable batteries can be placed on top of the household waste bin and collected with the normal waste (Bigum *et al.*, 2013:2373). Collection arrangements across countries thus differ significantly.

- ***Financing models for recycling e-waste***

In Europe, the financial responsibility to fund the recycling of household EEE lies with different stakeholders. It can be the distributor of EEE, the producers, or a municipal financing model. Even with directives governing e-waste recycling, member states in Europe have different financial models (Sander *et al.*, 2007:III). In Japan, recycling fees are paid by consumers when items are disposed, which is different from the European model (Kahhat *et al.*, 2008:957).

- ***WEEE design and treatment systems***

Eco-design refers to the development of cleaner, more durable, and energy efficient products in which toxic materials are avoided (Gottberg *et al.*, 2006:40). Japan is one of the countries who constantly adapt their Eco-design to ensure a better recycling yield, while the manufacturers have a direct physical obligation to ensure that e-waste gets recycled. This is contrary to the European Union (EU) situation, where manufacturers have a financial obligation to recycle e-waste (Aizawa, Yoshida & Sakai, 2008:1404-1405).

1.2.3 E-waste management in South Africa/developing countries

Household goods rank amongst the highest imported (in dollar value) goods into the South African market. Cellular phones, computers, televisions, radios, fridges and freezers, dishwashers and air conditioners are imported items that end up as e-waste after a few years (Workman, 2019). As a developing country, care must be taken to ensure the wellbeing of its citizens and the environment. In the sections to follow, the present conditions and mechanisms, or lack thereof, will be briefly discussed.

- ***Extended Producer Responsibility (EPR)***

EPR has not yet been implemented in South Africa, although the implementation of EPR on e-waste was identified as a priority more than five years ago (Advanced Tropical Environment, 2012:40). Currently there is still a lack of certainty around a legislative framework, directing EPR in the South African e-waste industry (South African E-waste Alliance, 2019).

- ***Stakeholder responsibility***

The stakeholders in the South African e-waste environment have been identified as producers (which include manufacturers and importers), retailers, consumers, collectors, recyclers, refurbishers, Government structures, e-waste associations, NGO's and environmentalists (Imran *et al.*, 2017:137; Lawhon, 2012:958). The exact roles and responsibilities of these stakeholders must still be explored in the current study to ensure a cohesive environment for the effective management of e-waste.

- ***Systems coverage and ensuring compliance***

Presently South Africa has no compliance scheme in place (South African E-waste Alliance, 2019), legislation around EPR is unclear, and no compliance is mandated. A compliance scheme is thus needed to give South African stakeholders direction.

- ***Registry of E-waste***

In the present South African context, the Government has a registration process called the "Manual registration form for registering with the South African Waste Information System (SAWIS)" (Department of Environmental Affairs, 2012). The SAWIS system however only requires persons involved with waste activities to register which excludes importers, manufacturers, and retailers and will not address the needs of a proper e-waste register. The need for a registry must be investigated as it could contribute to effectively managing an e-waste system.

- ***E-waste legislation in South Africa***

South African laws are applicable to e-waste also, as it includes areas such as water, the environment, air, hazardous substances, and waste as well as health and safety matters. If the laws are closely examined, answers could be extracted but it is confusing as the laws were implemented with a different perspective, and not from an e-waste point of

view (UNEP, 2009:59-60). Legislation of e-waste per se has not yet been introduced for South Africa and the appropriateness of introducing legislation, and which stakeholders must be included in the discussions, needs be determined.

- ***Collection arrangements of e-waste***

Recyclers in South Africa receive a wide range of electronic equipment and uncertified and informal recyclers have increased over the last years. Adding to this, e-waste is not regarded as a threat, which makes keeping track of e-waste difficult (Mhlanga, 2018). South Africa has approximately 59 million people (World Population Review, 2019), yet despite this large population, there seems to be limited e-waste collection points in the country. The Advanced Tropical Environment (2012:65) mentions a few drop-of points available in South Africa, but they are not ideal. Municipal drop off points are unsafe and not regulated when e-waste is disposed of by consumers, collection bins are impractical, and retailer collaboration buy-back systems are for short periods, e.g. typically one week in a year. The need, if any, for the collection and separation of different e-waste streams, as well as the most appropriate collection points and separation arrangements, must therefore be investigated.

- ***Financing models for recycling e-waste***

There are different financial models used by EU member states actively involved in WEEE. These financial responsibilities are covered by either the producer or the consumer, or jointly shared (Federico & Huisman, 2007:5). South Africa currently has no financing model in place and is in need of a WEEE framework that includes an efficient financial model, which will be proposed from this research.

- ***WEEE design and treatment systems***

South Africa has some e-waste recycling facilities but there is still a lack of such facilities and local beneficiation (Arnoldi, 2018). Another potential threat in the South African market is the use of backyard electrochemical unregulated processes, where precious metals can be extracted using electrochemical processes. This is a health hazard if the toxic chemicals are casually disposed (Finlay & Liechti, 2008:32). Environmental protection from e-waste in South Africa needs attention and the measures to ensure effectiveness in South Africa must be determined.

1.2.4 Green marketing and the theory of planned behaviour (TPB)

A green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2012). Green growth aims to foster economic growth and development while ensuring that natural assets and environmental services are protected and maintained. It is about recognising, understanding and acting on interconnections between the economy, society and the natural environment (GSP, 2012).

The ultimate objective of green marketing is economic development that is efficient and sustainable in the use of natural resources and minimises negative environmental externalities, while aiming at advancing the general welfare of humanity and broader society. E-waste contains complex hazardous elements and is, at present, one of the largest growing waste streams globally (Gupta, 2014:204). Following a stakeholder approach within green marketing, all stakeholders – consumers, companies and governments - are interrelated (Polonsky, 2011:1311) and the stakeholders have the ability to facilitate or impede green marketing from becoming transformational.

A major challenge often faced when aiming to get consumers to behave in an environmentally friendly or green manner is the green attitude-behaviour gap, i.e., the low relationship between consumers' attitude and their actions or actual behaviour (Joshi & Rahman, 2015:128). An approach to overcome this gap is the application of the Theory of Planned Behaviour (TPB), since it does not deduce from attitude to behaviour directly (Ajzen, 1991).

This theory has been verified to be able to explain and predict green consumer behaviour, such as eco-friendly activities performed by tourists (Han *et al.*, 2010:325; Lee *et al.*, 2010:901), intention of consumers' towards buying green products (Chaudhary & Bisai, 2018:798; Lizin *et al.*, 2017; Paul *et al.*, 2016:123; Yadav & Pathak, 2016:732; Yadav & Pathak, 2017:114) and household waste recycling behaviours (Chan, 1998:317; Nigbur *et al.*, 2010:259; Tonglet, Phillips & Read, 2004:191).

An individual's behaviour is a product of analytical process, which is influenced by three fundamental components: attitudes, subjective norms, and perceived behavioural control (PBC) (Pickett *et al.*, 2012:339). The fundamental components are the core of the TPB model. The TPB model will be used to determine which factors will be drivers or inhibitors towards behaviour from consumers, which will contribute to effective e-waste recycling.

1.3 RESEARCH PROBLEM

Several academics have considered WEEE management systems and practices in industrialising countries in an attempt to provide solutions to the increasing quantities of e-waste (Parajuly, Habib & Liu, 2017; Ylä-Mella, Poikela, Lehtinen, Keiski, & Pongrácz, 2014, Zacho, Bundgaard & Mosgaard, 2018). Recently some studies compared the WEEE management in different countries (Garlapati, 2016; Khan *et al.*, 2014; Lepawsky, 2012; Nnorom & Osibanjo, 2008; Oliveira, Bernardes & Gerbase, 2012; Ongondo, Williams & Cherrett, 2011; Salhofer *et al.*, 2016; Sthiannopkao & Wong, 2013; Torretta *et al.*, 2013; Zeng *et al.*, 2013).

Limited studies on WEEE management systems and practices in developing countries could be found (Manomaivibool & Hong, 2014; Rousis *et al.*, 2008; Yang, Lu & Xu, 2008), and none of these investigated WEEE management systems and practices in South Africa.

Additionally, various quantitative surveys with consumers have been conducted to determine the determinants of their e-waste recycling and disposal behaviour. These studies predominantly focused on developed markets (Saphores *et al.*, 2012; Tonglet *et al.*, 2004; Ylä-Mella, Keiski & Pongrácz, 2015). Recently consumers in developing markets, such as Brazil (Echegaray & Hansstein, 2017), Vietnam (Nguyen *et al.*, 2018) and China (Wang *et al.*, 2016; Zhang *et al.*, 2016; Zhong & Huang, 2016), have been surveyed on their e-waste recycling and disposal practices, but none of these investigators examined South African consumers to identify the drivers and inhibitors of e-waste recycling behaviour in this context. Furthermore, scholars on this topic typically followed either a qualitative or quantitative research approach and did not apply a mixed methods research design.

This important issue of e-waste has remained underexposed in the South African context, despite the fact of drastically increasing storage-stockpiles and e-waste production levels (Department of Environmental Affairs, 2018:26) and limited success of reuse, refurbishment and recycling efforts in developing countries (Vaccari *et al.*, 2019:2). Therefore, this research intends to offer an integrated summary of the stakeholders' views on WEEE management (qualitative research) and the determinants and inhibitors of consumers' e-waste behaviour intentions (quantitative research) in the South Africa context.

1.4 RESEARCH AIM AND OBJECTIVES OF THE STUDY

1.4.1 Research aim of the study

The aim of this study is to propose a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

The research objectives of each of the three phases are presented next.

1.4.2 Research objective and questions of the qualitative phase

Research objective 1:

To explore the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

To meet research objective 1 related to the qualitative phase, the following three research questions were answered:

Research questions:

- RQ1a: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste collection from household consumers?
- RQ1b: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste distribution to recyclers?

- RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

1.4.3 Research objective and hypotheses of the quantitative phase

Research objective 2:

To examine the drivers and inhibitors of e-waste recycling behaviour intentions of South African household e-waste consumers.

In order to meet research objective 2, related to the quantitative phase, the following nine hypotheses were tested:

Hypotheses:

- H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.
- H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.
- H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.
- H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.
- H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.
- H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.
- H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.
- H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.
- H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

1.4.4 Research objective and questions of the integration phase

- **Reach objective 3:**

To advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) could be addressed, via mechanisms to co-ordinate and drive the e-waste management processes in South Africa (qualitative results).

To meet research objective 3 related to the integration phase, the following three research questions were answered:

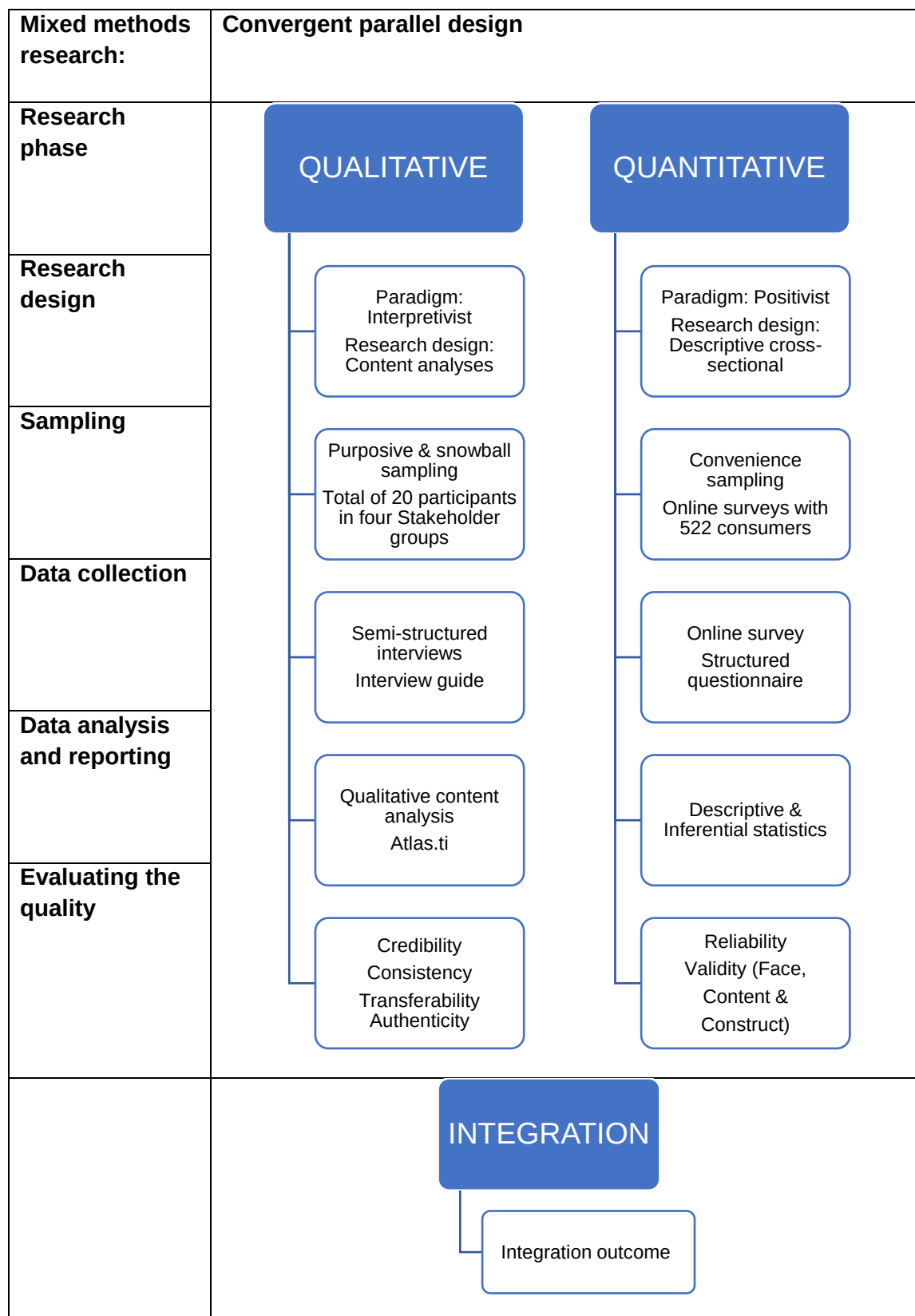
Research questions:

- RQ3a: How can personal convenience of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?
- RQ3b: How can attitude towards e-waste recycling of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?
- RQ3c: How can environmental awareness of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

1.5 RESEARCH DESIGN AND METHODOLOGY

This section describes the research design, sampling strategy, data collection method, and data analysis procedures used in the qualitative and quantitative phases of this study. It also includes an integration component. A research design is a plan or blueprint to conduct a research study and guides the data collection and analysis (Babbie & Mouton, 2001:74). In this study, a convergent parallel design was employed in which qualitative and quantitative data are collected in parallel, analysed separately and then merged (Creswell & Plano Clark, 2007:20).

Figure 1.1: Framework of the research design and methodology



Source: The Researcher

Qualitative data was collected via semi-structured interviews to explore the current practices and views of participants in four key stakeholders' groups on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. The quantitative data was collected via online surveys with 522 consumers. Development of the hypotheses was guided by the theory of planned behaviour and testing was done by applying Structural Equation Modelling (SEM). Integration was done in order to understand how the key contributors to consumers' behavioural intentions can be delivered on via mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

The main components of the research methodology of the phases of this study will now be described briefly as depicted in Figure 1.1.

1.5.1 Methods applied in the qualitative phase

An inductive qualitative content analysis was applied as the research design in the qualitative phase. An inductive qualitative content analysis is an engagement with collected data to establish important themes or categories and relationships between them. This type of qualitative design helps to develop rich and thick descriptions from the raw data to convince any reader of the trustworthiness of the results (Merriam & Associates, 2002:15).

The researcher applied two non-probability sampling techniques to recruit experts in the fields of e-waste management across South Africa. Purposive sampling was applied by selecting participants based on the researcher's knowledge and experience of research field and industry. Snowball sampling was applied by requesting research participants to suggest and help recruit other suitable experts as participants.

Semi-structured interviews were applied as the data collection method to address the qualitative research question. Semi-structured interviews use pre-existing interview guides where participants are allowed to elaborate on topics and the interviewer can delve deeper into the topics raised (Corbin & Strauss, 2015:37).

The interviews were conducted with 20 participants from four key sectors in the e-waste scenario to ensure inclusiveness and expansiveness, as a broad range of perspectives and views had to be covered (DePoy & Gilson, 2008:108). Four of these participants represented environmental specialists, nine represented government authorities, five represented recycling/disposal entities and two participants represented supply chain members in South Africa.

The hermeneutics software package, ATLAS.ti (Version 8), was used for the analysis of the qualitative interviews. From the transcriptions of the interviews, meaningful and contributing segments were identified and coded. The codes were analysed for general similarities and then grouped into categories. The categories were then analysed for higher order connectivity and grouped into themes. The use of ATLAS.ti allowed the researcher to create visual displays in the form of conceptual network diagrams. This enriched the findings by helping the reader to better understand and visualise the findings. Conceptual network diagrams were developed based on the key themes derived during the data analysis.

Lincoln and Guba (1985:289) advocate the use of key criteria namely credibility, dependability, transferability and authenticity to evaluate the quality of qualitative studies. A number of strategies were implemented to enrich the trustworthiness of the study.

1.5.2 Methods applied in the quantitative phase

The quantitative phase followed a descriptive cross-sectional design, whereby data is collected at a single point in time from a sample (Singh, 2007:65).

Convenience sampling was used to select consumers in the quantitative phase. Researchers often rely on convenience sampling, as it is a relatively easy, fast, and inexpensive method of collection data (Explorable, 2009). Results of a study based on a non-probability sampling are not generalisable to the population. However if the sample size increases, there is an increase in statistical power of the convenience sample (Etikan, Musa & Alkassim, 2016:4).

Data was collected via an online structured questionnaire from a total sample size of 522 respondents residing in the five large cities (City of Cape Town, City of Johannesburg; Ekurhuleni; EThekweni-Durban; and Tshwane-Pretoria) as well as medium and smaller sized towns in South Africa. A link to the online questionnaire was distributed to the database of a reputable research house.

The six constructs included in the measurement instrument (environmental awareness; attitude towards e-waste recycling; norms and publicity; cost of recycling; convenience of recycling; behavioural intention) were adapted from previous studies (Wang, Guo & Wang, 2016:859; Zhong & Huang, 2016:479).

The data was analysed on the Statistical Package for Social Sciences (SPSS) version 25. In order to compile a demographic profile of respondents and frequencies for the respective constructs descriptive statistics were employed. Exploratory factor analysis was applied to assess the suitability of data for factor analysis and to determine the number of factors to retain. T-tests, the analysis of variance (ANOVA) tests, and the Spearman's rank order correlation were conducted to measure the effects of biographical variables on the factors. The SPSS package version 25 was applied to conduct structural equation modelling to test the set hypotheses.

Reliability is concerned about consistent measurement, thus getting the same outcome every time it is applied (Singh, 2007:77). To assess the reliability and internal consistency of the constructs the Cronbach's alpha was used.

A direct measurement of face validity was obtained by asking colleagues to assess the questions in the questionnaire. To ensure content validity, the researcher conducted an extensive literature review identifying relevant items and constructs. A supervisor also monitored the process to ensure face validity. Reliability tests were done during the pilot test as well as during the final analysis. The constructs were analysed to determine relationships between them for hypotheses testing, thus ensuring construct validity.

The researcher followed the guidelines of the University of North West's Ethical Committee in executing the research in the qualitative and quantitative phases of the study.

1.5.3 Integration phase

Integration as a key component of mixed method research refers to the explicit interrelating of the qualitative and quantitative component of a mixed method study (Creswell & Plano Clark, 2007:202). Integration of mixed method studies requires interconnection in reaching a common theoretical or research goal (Bazeley, 2009:204). For this study, a convergent parallel design mixed methods design was applied to provide a comprehensive and complete understanding of the phenomena of e-waste in South Africa from the perspective of key stakeholders and consumers.

Integration in the current mixed method research study was implemented in the design as well as interpretation and reporting levels. Guided by the advice of Creswell and Plano Clark (2007:20), convergent parallel design integration at the design level for the current study involved independent collection and analysis of the qualitative and quantitative data at a similar time. This was followed by an integrated analysis focusing specifically on the three biggest contributors to behavioural intention (personal convenience, attitude towards e-waste recycling and environmental awareness). Integration at the interpretation and reporting level was done by creating joint displays. Joint displays is a method to represent and assist data integration through a visual means to draw out new insights beyond the information gained from the separate quantitative and qualitative results (Fetters, Curry & Creswell, 2013:2137).

1.6 PROPOSED CONTRIBUTION OF THE STUDY

The researcher will indicate in this section what the contribution will be to the engineering discipline. This will be followed by a description of the contribution, which will be made to the body of knowledge, and concluded with the methodological contribution that will be made.

1.6.1 The contribution to the discipline

The International Council on Systems Engineering (INCOSE) asserts that the retirement stage or decommissioning and disposal of a product is of vital importance due to the increased awareness of environmental issues (Haskins, 2006:3.1).

The 20th century experience repeatedly demonstrated the consequences when system retirement and disposal were not considered during the design stages of a product. Several countries have changed their laws to hold the creator of a system-of-interest accountable for proper end-of-life disposal of the system (Haskins, 2006:3.9). A study into the management of e-waste can involve many disciplines and different scholars depending from which angle the study is approached. Scholars from a financial background would engage e-waste management from a different angle compared to someone with a scientific background; all scholars could however contribute to an e-waste management programme from their respective disciplines. Emphasis is placed on the design of electrical and electronic products, but there is a general lack in the final retirement stage around the globe. E-waste is the by-product of designs from engineers and it is essential that the lifecycle ends with appropriate recycling or disposal efforts. This is to prevent negative consequences from unsafe recycling practices. Different research methodologies have been employed to determine the e-waste recycling habits and intentions of households around the globe and a comprehensive study was long overdue in the South African setup. The safe and effective disposal of any hazardous waste stream is imperative for any country and a constitutional right of citizens. To accomplish this, different disciplines and sub-disciplines need to co-ordinate efforts for a system to be effective.

The desire to get involved in a study on e-waste emanated from an understanding of the fields of electronic engineering, business management, and the challenges posed to get synergy in e-waste recycling by involving the different stakeholders in the study. The fact that e-waste is an ever increasing problem urged the researcher to conduct the study and to develop roadmaps for e-waste management in South Africa. What makes it an engineering management study is the fact that it includes financial issues, logistical arrangements, social factors, environmental protection, management models, supply chain management, and technology management, to mention a few (IEEE-TEMS, 2019). Contributions to the engineering management discipline will be made in the following areas:

- ***Social***

The study will propose measures to address the e-waste problem. Social issues caused by exposure to toxic elements will be reduced and could be eliminated if the findings were to be implemented in the future. Cancer and deaths are possible social issues resulting from e-waste. A contribution will thus be made in the study, which will address the e-waste related social issues.

- ***People***

Engineering management normally focuses on people in organisations. E-waste originates with consumers and thus they are a vital component in the e-waste value chain. The attitudes, perceptions, drivers, and inhibitors will be explored in the study. A contribution will be made when the factors that motivate consumers have been elicited.

- ***Framework***

A conceptual framework will be presented on completion of the study. The framework will be an original design employing two methodologies. Valid and reliable results will support the framework. The framework will thus be an original contribution to the engineering management discipline, and a roadmap to manage e-waste in South African.

- ***Sustainability***

The ultimate aim is to get an e-waste recycling system going in South Africa that is sustainable in the green economy market. The multidisciplinary nature of the phenomena was mentioned and the researcher will involve as many stakeholders in the e-waste industry as possible. This includes consumers, producers (importers and local manufacturers), retailers, collectors, recyclers, environmentalists, and Government entities. The integrated methodological approach, where different stakeholders' views and experiences will be explored, will address financial and environmental sustainability. A contribution will thus be made, as the researcher will address health and safety issues, which are key principles in engineering management.

- ***Supply chain management***

The poor performance in the South African e-waste recycling industry is indicative of a value chain in need of attention. The current e-waste value chain has limiting factors which needs investigation. This study should address the issue and a contribution will be made to the supply chain management domain.

It is envisaged that this study will realistically demonstrate how an engineering management research approach will expose the current factors that obstruct the effective management of e-waste in South Africa. Furthermore, a critical analysis has been done on the role of all governmental entities as well as non-governmental groups in the generation and management of e-waste. A significant contribution will be made to the engineering management field with the management model, which addresses the engineering areas.

1.6.2 The contribution to the body of knowledge

Scholarly research focused predominantly on WEEE management systems and practices in industrialising countries (Bahers & Kim, 2018; Dias, Bernardes & Huda, 2018; Duygan & Meylan, 2015; Morris & Metternicht, 2016). Studies on WEEE management systems and practices have been done in developing countries (Ciocoiu, Burcea & Tartiu, 2010; Dias *et al.*, 2018; Manomaivibool & Hong, 2014); however, none of these studies explored WEEE management systems and practices in South Africa. The study aims to fill this gap and contribute to the body of knowledge by offering insight on the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

Furthermore consumers' e-waste recycling and disposal behaviour in developed markets have received far more attention than developing markets (e.g. Hansmann *et al.*, 2006; Lizin *et al.*, 2017; Nixon & Saphores, 2007). South African household e-waste consumers have not been studied to identify the drivers and inhibitors of their e-waste recycling behaviour. This study aims to fill this gap and contribute to the body of knowledge by offering and applying the theory of planned behaviour (TPB) model to examine e-waste recycling behaviour intentions of South African consumers.

The current study will also offer guidance on how major contributors to e-waste recycling behaviour intentions of consumers could be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South Africa; this has not been done in previous studies.

1.6.3 Methodological contribution

In the qualitative phase, a detailed and accurate account will be supplied on the research design, data collection and data analysis processes. This could guide future researchers on this topic as well as studies on the recycling of other recyclable waste types, such as tyre recycling which previously used a management model that failed.

For the quantitative phase, several scales will be integrated in the measurement instrument to determine the drivers and inhibitors of e-waste recycling behaviour intentions of South African e-waste consumers. The instrument could thus be applied to validate and extend the TBP to other recycling and green marketing behaviours of consumers.

Based on researcher's knowledge, this will be one of the first studies on e-waste to be informed by a mixed methods approach. A key methodological contribution of the current study will be that it is one of the first mixed method studies aimed at offering an integrated summary of the determinants and inhibitors of e-waste behaviour intentions (quantitative research), and views (qualitative research) of WEEE management by stakeholders.

1.7 LIMITATIONS OF THE STUDY

Geography, study subjects, and theory define the scope of the current study. The geographical system boundary for the current research and data collection is South Africa. The researcher is a South African citizen and employed at one of the Universities in Gauteng Province. Research is one of the core pillars of any university and the researcher became aware of the e-waste problem in South Africa through the involvement in an e-waste related project. Initial investigation revealed that South Africa has a poor e-waste recycling system and recycling is executed by the informal sector.

Similar findings were made by Vaccari *et al.* (2019:2), and the authors urge developing countries to implement measures urgently that will improve e-waste treatment and reduce health and environmental impacts. Thus, the researcher undertook this study to contribute to reducing the harmful effects caused by an inefficient e-waste recycling system. Secondly, the study was also limited in terms of study subjects in the South African context. Accordingly, participants representing four key stakeholder groups in South Africa, particularly environmental specialists, government authorities, recycling/disposal entities and supply chain members were interviewed for the qualitative phase. Consumers from the City of Cape Town, City of Johannesburg, Ekurhuleni, eThekweni-Durban, Tshwane-Pretoria and selected mid-size and small towns (e.g. Pietermaritzburg, Rustenburg, Vanderbijlpark, and Paarl) were the sample for the online survey of the quantitative phase of the study. The South African population is close to 59 million (World Population Review, 2019), which means that the sample size of 522 is relatively small compared to the total population. The convenience sample was obtained from mainly urban consumers. Statistical inferences could not be done for the South African population as a whole. Financial and time limitations prevented the researcher from collecting a statistical representative sample of the South African urban household population. However, the sample which was obtained, resulted in effective statistical analysis and was large enough to do effective statistical analysis in the form of Structural Equation Modelling (SEM). The results from this study will guide implementers of the framework to focus on the constructs which proved to have positive and negative relationships towards e-waste recycling behaviour intentions of urban consumers. After implementation, future research can focus on fine tuning consumer behaviour and e-waste recycling intentions. Consumers from households in rural areas and outside these towns were not part of this study because they could not access the online survey link that was sent out as the instrument was designed for urban consumers. Furthermore, educational institutions, and government sector offices in South Africa were not the focus of this study.

Thirdly, literature informing the qualitative phase of this study focused on key e-waste management parameters (mechanisms to co-ordinate and drive the e-waste management processes; regulation and legislation; collection and system coverage arrangements of e-waste; and financing models for recycling e-waste). A global and local perspective on these e-waste management parameters are presented in Chapters 2 and

3. The quantitative phase of the study was informed by the TPB model, because it has been proven to predict consumers' long-term recycling commitment in a developing context (Chaisamrej & Zimmerman, 2014) and has been applied in other studies published in prominent journals (Echegaray & Hansstein, 2017; Hansmann *et al.*, 2006; Nguyen *et al.*, 2018; Nixon & Saphores, 2007; Saphores *et al.*, 2012; Tonglet *et al.*, 2004; Wang *et al.*, 2016; Ylä-Mella, Keiski & Pongrácz, 2015; Zhang *et al.*, 2016; Zhong & Huang, 2016).

1.8 DEFINITIONS OF KEY TERMS

This study uses a number of key concepts throughout. These concepts can be defined as follows:

- WEEE or e-waste: Refers to any electrical or electronic device, which uses batteries or electricity, or generates electricity.
- Collection arrangements: Refers to the collection strategies to collect e-waste from household consumers.
- Disposal: Refers to methods to dispose of e-waste.
- Extended producer responsibility: Refers to a principle of making producers responsible to implement measures to dispose of e-waste effectively.
- Producer responsibility organisation: Refers to a body with a special management component who needs to drive and manage the process of e-waste recycling.
- Recycling: refers to the processes to extract valuable and hazardous fractions.
- Recycling fee: Refers to a fee, which will be used to cover all costs associated with the management and recycling processes of e-waste.
- Re-use: This refers to items being re-introduced into the electrical or electronic sector by either changing hands or items being repaired for further use.
- Stakeholders: Refers to everyone who can contribute to recycling e-waste effectively.
- WEEE management: Refers to the structure and processes to ensure the effective and sustainable recycling of e-waste.

1.9 ABBREVIATIONS AND ACRONYMS

The acronyms and abbreviations used in this document are listed in Table 1.1.

Table 1.1: List of abbreviations and acronyms

ANOVA	Analysis of Variance
ARF	Advanced recycling fee
CFI	Comparative Fit Index
CFL	Compact Fluorescent Lamp
CRT	Cathode Ray Tube
DFE	Design For Environment
EEE	Electrical and Electronic Equipment
EoL	End of life
EPAT	Environmental Protection Administration of Taiwan
EPR	Extended producer responsibility
EU	European Union
E-waste	Waste Electrical and Electronic Equipment
eWASA	e-Waste Association of South Africa
ICT	Information and Communication Technology
ITAC	The International Trader Advisory Commission
KMO	Kaiser-Meyer-Olkin
LDA	Large Domestic Appliances
MSWM	Municipal Solid Waste Management
OECD	Organization for Economic Co-operation and Development
PAYG	Pay-As-You-Go
PC	Personal Convenience of e-waste recycling
PCA	Principal Components Analysis
PRO	Producer Responsibility Organisation
PRS	Points Rewards System
PWMA	Public Waste Management Authority
RFMB	Recycling Fund Management Board
RMSEA	The Root Mean Square Error of Approximation
ROHS	Removal of Hazardous Substances
RRW	Regulated Recyclable Wastes
SARS	South African Revenue Services
SAWIS	The South African Waste Information System
SCM	Supply Chain members
SEM	Structural Equation Modelling
SPSS	Statistical Package for Social Sciences
TPB	Theory of Planned Behaviour
UAE	United Arab Emirates
UNEP	United Nation Environment Programme
USA	United States of America
WEEE	Waste Electrical and Electronic Equipment

1.10 THE RESEARCH OUTLINE

This thesis consists of the following nine chapters:

Chapter 1 introduces the study. It offers a brief introduction to the background, the research problem, research aim and objectives of the study. This was followed by an explanation of the research design and methodology as guided by an illustrative framework. The contribution and limitations of the study are considered. Thereafter the key terms, abbreviations and acronyms of the study are presented.

Chapter 2 reviews current WEEE practices and essential elements contributing to effective e-waste recycling around the world as derived from available relevant literature. Some key measures to address WEEE recycling are discussed by considering mechanisms to co-ordinate and drive e-waste management processes, legislation, collection arrangements of e-waste, and financing models for recycling e-waste.

In Chapter 3, mechanisms to co-ordinate and drive e-waste management processes are considered for a South African context. The lack of appropriate implementation in the specific areas are also underlined.

Chapter 4 reviews green marketing as a way to obtain a green economy. The TPB applied to WEEE recycling research are discussed and the theory informing the development of the nine hypotheses is presented.

Chapter 5 discusses the research design and methods applied in the study. The qualitative and quantitative research components of the mixed methods approach followed are discussed as well as the methods and procedures followed. The quality issues of both the qualitative and quantitative research, as well as the measures applied to ensure the ethical research conduct are presented.

Chapter 6 discusses the qualitative findings and discussion. A description of the participants who contributed to the research is offered. A brief description of each participant's involvement in the research setting is given.

This is followed by an overall graphical layout of the codes, categories and themes developed from the analyses of the interviews. The overall findings as they relate to the qualitative research questions, the themes, and categories are discussed in detail in this chapter.

Chapter 7 focuses on the presentation and results of the analysis of the quantitative data. The reliability tests conducted on the factors are discussed. This is followed by the analysis via T-tests, Anova tests, hypothesis testing using Structural Equation Modelling (SEM). Lastly, the proposed model is presented.

Chapter 8 reports on the integration phase of this empirical study. The chapter presents the integration of the qualitative and quantitative phases of the current mixed methods research study.

Chapter 9 concentrates on summarising, concluding, and giving recommendations based on the findings obtained from this mixed methods study. The chapter proposes a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. The main contribution, limitations and recommended areas for future study are presented.

CHAPTER 2: A GLOBAL PERSPECTIVE ON E-WASTE MANAGEMENT

2.1 INTRODUCTION

The purpose of this chapter is to offer some background on current WEEE practices and to highlight the essential elements contributing to effective e-waste recycling around the world as derived from relevant literature. The practices around the globe with regard to these elements will be discussed to examine the implementation strategies of different countries. Topics such as legislation, producer responsibility, financing models, and compliances systems will be reviewed. The same elements will be used in Chapter 3 to compare the situation in South Africa with other countries. The aim is to review the current measures, potential shortcomings and progress to date in terms of the elements.

2.2 DEFINING AND CLASSIFYING E-WASTE

Electronic waste (e-waste) is a broad term used when referring to a wide range of electric and electronic appliances that are at the end of their life, because they ceased to be of any value to their owners (Widmer *et al.*, 2005:436).

E-waste is classified differently in different regions and different contexts across the globe. Forti, Baldé and Kuehr (2018:48) assert that a taxonomy for e-waste ought to sort products by comparable function, similar material composition and related end-of-life features. This implies that products within the same category should have a similar average weight and lifetime usage. The European waste electrical and electronics equipment (WEEE) classify e-waste in 10 major categories namely (i). Major household gadgets, ii). Minor household gadgets, iii). IT and telecommunication gadgets, iv). User gadgets, v). Illumination gadgets, vi). Electrical and electronics apparatus, vii). Toys, leisure and sports gadgets, viii). Medical devices, ix). Monitoring and control instruments and x). Automatic dispensers). The International Solid Waste Association takes into account six waste categories in their Global E-waste monitor (i). Cooling and freezing equipment, ii). Screens and monitors, iii). Lamps iv). Large equipment and iv). Small equipment) (Baldé *et al.*, 2017).

This study will be guided by the classification from Forti, Baldé and Kuehr (2018:48) and the classification of ten categories done by the European Union. The former classification is preferred because they classify e-waste into related functions, similar material composition and related end-of-life features. This implies that similar type e-waste will be grouped in categories, such as cooling equipment, IT equipment, lighting, and general e-waste. The study will investigate which classification into categories will be best suited for the South African scenario as the ten categories could be too much for a small country. The lack of facilities in the South African context will be investigated and reported in Chapter 3.

2.3 THE VALUABLE AND TOXIC NATURE OF E-WASTE

E-waste has become a serious challenge due to the volumes of e-waste being generated and the content of both toxic and valuable materials within them (Garlapati; 2016:877). E-waste volumes are increasing due to the rapid depreciation of EEE products as well as the product lifespan of electronic devices, which are deliberately curtailed (Echegaray, 2016:191). In a study conducted by Bereketli *et al.* (2011:78) to determine the best treatment options between re-use, recycle and disposal, their mathematical calculation concluded that the best methods for treating e-waste was re-use and recycling. Re-use and recycling will also contribute to either local or global economies due to the creation of a new business sector, employment and the reduction of scarce resources. E-waste contains toxic and valuable materials, which was regarded as a predicament. However, there can also be business opportunities, but the toxic content is problematic. At the time, general e-waste fractions had gold, copper, aluminium, iron, and other metals of more than 60%, and pollutants of around 2.7% (Widmer *et al.*, 2005:436). It is estimated that 40% of the lead in the United States of America (USA) landfills comes from consumer electronics, and e-waste contributes to about 70% of the heavy metals (mercury and cadmium) in landfills (Widmer *et al.*, 2005:444).

More than a 1000 different substances are found in e-waste components. The Material Safety Data Sheet and regulations related to hazardous waste of different countries set minimum standards for exposure to substances, and in e-waste the substances go above the minimum threshold quantities, making it “hazardous” (United Nations Environment Program-Volume I, 2007:30). E-waste elements that fall into this classification are

selenium, mercury, lead, cadmium, arsenic, flame-retardants and hexavalent chromium. Some valuable materials that can be extracted include gold, silver, palladium, platinum, copper, aluminium, iron, steel and plastics. The Material Safety Data Sheet is a comprehensive list, which provides information on hazardous substances in products, explosion or fire hazard data, toxicological properties, reactivity data, physical data and the effects on the health of humans, applying first aid and more. Burning of e-waste, especially to retrieve copper from insulated wires, can cause air transport of pollutants. Inhalation or contact with some of these elements can lead to serious illnesses or even result in deaths (Eren, 2014).

The hazardous substances in e-waste have effects on the environment and health of humans, such as allergic reactions-asthmatic bronchitis, abdominal cramps, vomiting, nausea, diarrhoea, DNA damage, irregular heart rhythm, a reduced production of red and white blood cells, blood pressure problems, breathing problems, numbness of the face, weakness of muscles and paralysis. Some of the substances are known human carcinogens causing cancer and possibly death (Ejiogu, 2013:202-203). Chlorofluorocarbons, used in refrigeration equipment causes depletion of the stratospheric ozone and due to the greenhouse effect, contributes to global warming (Tsai, 2014:883).

In the preceding section, a few toxic substances and the effect of exposure to it were highlighted. Mention was made of valuable materials that can also be extracted. It is evident that e-waste, if treated incorrectly, can lead to serious illnesses and even cause deaths in humans and animals. For this reason, e-waste and the management of it should be treated as important in order to minimise exposure of people and animals to the effects of toxic e-waste substances. The responsible management of e-waste around the world and in South Africa is thus of vital importance. On top of the toxic concerns, the valuable materials found in e-waste are extracted around the world and thus contribute to the economy and job creation.

2.4 E-WASTE MANAGEMENT PARAMETERS

In this section, key parameters for an e-waste management system will be identified and discussed.

The guidance notes of the UNEP-Volume II (2007:35-37), also referred to as the “e-waste management manual,” proposes the following actions to manage e-waste effectively:

- Influential e-waste stakeholders must be identified to ensure that acceptable e-waste laws, policy, and regulations address environmental health.
- The roles and responsibility of specific stakeholders must be clarified. Key stakeholders include the originator/consumer, producer, exporter, importer, collection and transport stakeholders and registry administrators. Roles need to be clarified in order to develop a suitable e-waste mechanism.
- Suitable collection areas, collection point numbers, storage facilities, and locations should be determined.
- The disposal methods for non-recyclable and hazardous e-waste fractions must be determined (UNEP-Volume II, 2007:73-76).
- The e-waste treatment, collection, and transportation system, as well as bills of quantities (inventory of items), must be factored in for financing purposes. A detailed cost estimate of an e-waste management system must also be done as well as a forecast of revenue streams from sale of output by recyclers to raw material producers over a period of 10 years, 20 years or more (UNEP-Volume II, 2007:93-95).

Key parameters required of a WEEE management system include the following (Widmer *et al.*, 2005:447-448):

- ***Mechanisms to co-ordinate and drive the e-waste management processes***

In the design of an effective WEEE system, the producer plays a crucial role. How much, at which point, and how the responsibility of the producer is shouldered are some of the key issues to address. Producers could individually be accountable, but different manufacturers can still form a collective WEEE management system by working together. A flexible system is also possible where the producer takes responsibility on an individual as well as on a collective implementation basis.

In WEEE systems, free riders should be limited. Free riders are stakeholders who get benefits from sales but are reluctant to contribute to ensure that the system is financially sustainable. Checks and balances in such a system are needed for effectiveness. To

ensure compliance, penalties for low collection or recycling targets and for non-compliance are used. The measures in such a system could vary from very high in density to none in extreme cases.

- ***Regulation and Legislation***

This parameter deals with the operational management of the system by ensuring that suitable and efficient legislation is in place to address the management and disposal of e-waste.

- ***Collection and system coverage arrangements of e-waste***

A key consideration is to decide between a collective system including all brands or a brand-specific system making all brand owners accountable individually. Another aspect to consider is whether the system needs to accommodate all different product categories or will there be many systems under the WEEE umbrella for different kinds of WEEE categories.

- ***Financing models for recycling e-waste***

This parameter deals with how much must be paid, for what, and who will be responsible for payment. One financing option is a financial system that is entirely external, which means that finances needed to collect and recycle are paid by the municipality, the user of the product, or the producer who will provide the funds the end-of-life treatment of the WEEE product. Another financing option is an internal system where the collection and recycling are funded by using a portion of the fee of the product itself.

These key parameters on e-waste management will be discussed in detail in the following sections. The UNEP-Volume II (2007:35-37) report and the research from Widmer *et al.* (2005:447-448) is an indication of the importance of determining who the role-players should be in the e-waste management process. The same mechanisms are highlighted, but the sources does not restrict the management to a few role players. The correct combination of stakeholders and mechanisms to manage e-waste in South Africa will thus be the focus of this research.

2.5 MECHANISMS TO CO-ORDINATE AND DRIVE THE E-WASTE MANAGEMENT PROCESSES

2.5.1 Introduction

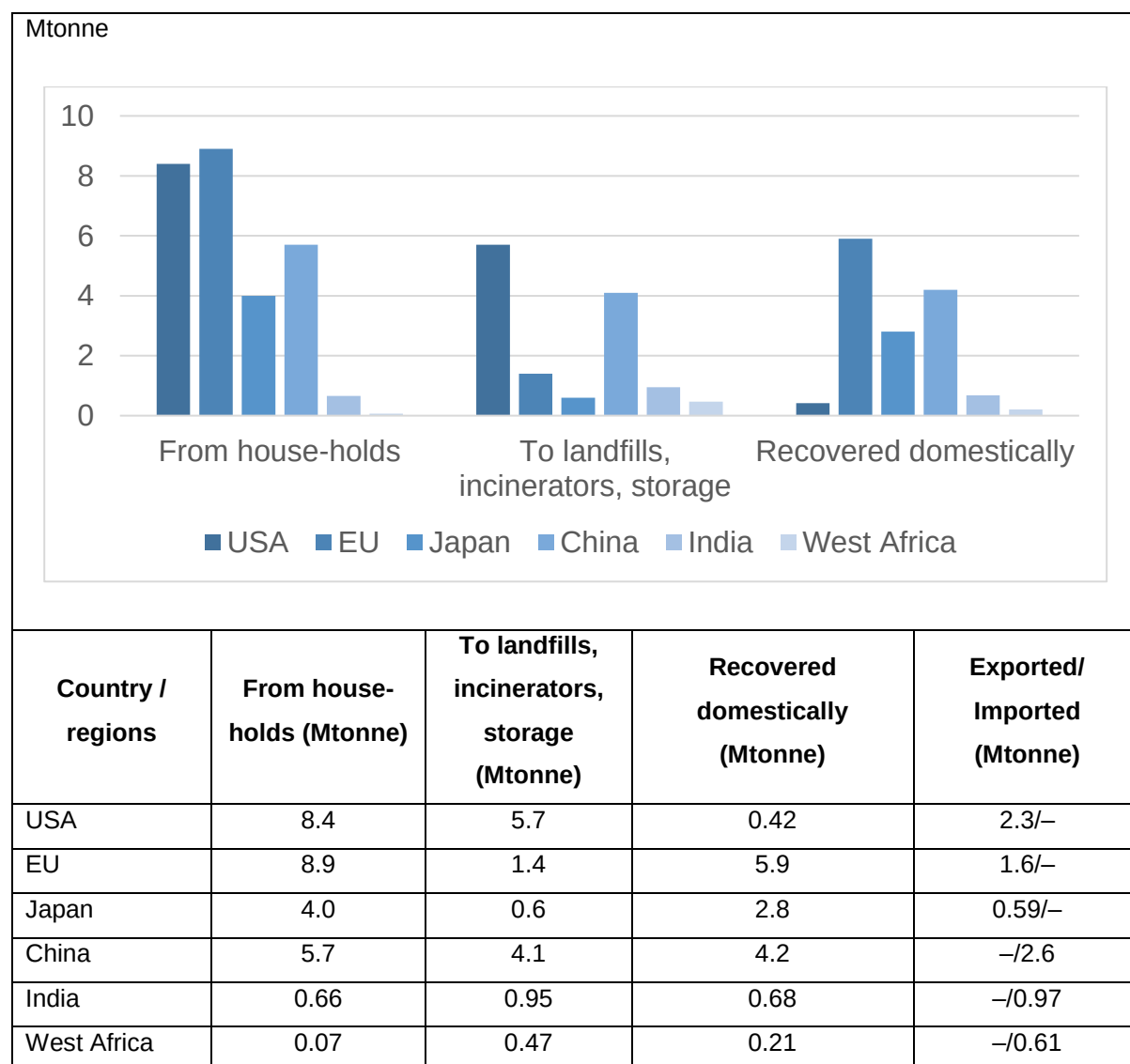
Fredholm (2008:24) compared e-waste management across nine countries and concluded that different countries have different levels of success. These results showed that European Union members, Belgium and the Netherlands, had e-waste collection rates of just above 1 kg/capita/year for category 3 equipment (IT and Telecommunications), while Sweden had almost 3 kg per capita collected, three times as high. Two other European countries, namely Switzerland and Norway, had 3.75 and 2.3 kg/capita collected per year respectively. Three American states, namely California, Maine and Maryland, showed collection figures of 0.7, 0.4 and 0.2 kg/capita per year respectively, while the Canadian province of Alberta had a figure of 0.5 kg/capita/year collected. The Canadian collection rate has increased considerably since then as the collected e-waste in 2012 for Canada ranged between 3.34 kg/person (Ontario) to 5.61 kg/person (Saskatchewan) with an average of 4.53 kg/person. It should also be noted that the average percentage of consumer awareness of recycling was a high 76.4% at the time (The WEEE report, 2013:39). This illustrates that Switzerland, at the time (2008), was one of the world leaders in effective e-waste management but that countries such as Canada quickly adapted to increase the collection rate.

From the above, it may be concluded that some countries have success in dealing with e-waste while others have failures. By purely looking at the figures of e-waste recovery per capita, the assumption can be made that if all countries adopt the same methods as Switzerland the e-waste problem would be solved around the world. This preposition is a total oversimplification as different countries have different cultures, attitudes, social problems and behaviours, economic drivers, financial means, infrastructures and many more. Each country has to implement measures that are best suited for their own circumstances with the aim of effectively dealing with the e-waste problem. The success of a system in some developed countries does not guarantee success in other developing countries (Borthakur & Govind, 2018:1056). The culture in a country where the materials flow takes place must be understood in order to develop a sustainable e-waste system. The Information and Communication Technology (ICT) infrastructure, the physical flow of

materials, and the incentives all contribute to a system that is sustainable and responsive (Kahhat *et al.*, 2008:958).

Garlapati (2016:877) offers a more recent perspective on e-waste disposal and recovery practices in some developed and developing countries, as seen in Table 2.1 below. The EU produced the most in terms of household and domestic recovery. The USA was the highest in term of landfills, incinerators and storage. India and West Africa were comparatively lower, however developing countries are expected to produce e-waste double that of developed countries within the next decade.

Table 2.1: E-waste disposal and recovery practices of some developed and developing countries



Source: Garlapati, 2016:877

Each country has its own social, economic, and cultural drivers as well as an infrastructure that can or cannot support the effective management of e-waste. For e-waste management to be effective, these drivers, limitations and capabilities need to be assessed to determine the best fit for effective e-waste management. Table 2.1 shows that even between developed countries there are disparities in e-waste recycling while developing countries compare dismal with developed countries. The approach of finding the best fit for addressing the e-waste problem is needed for the South African scenario as social and cultural differences as well as economic drivers are very prevalent.

2.5.2 Extended Producer Responsibility (EPR) and product stewardship (PS)

To manage end of life (EoL) equipment effectively, two major strategies can be employed to collect and recover e-waste (Nicol & Thompson, 2007:227). The first strategy takes the form of a product stewardship scheme, while the second is based on the extended producer responsibility (EPR) principle.

Product Stewardship is an environmental management strategy where everyone has to take responsibility for minimising a product's environmental impact. Whoever designs, produces, sells, or uses a product must take the product through all the stages of the life cycle, including EoL management. This EoL management principle is applied in some North American states (NWPSC, 2019) as well as in Australia (Australian Government, 2011).

EPR refers to a strategy to protect the environment by reducing the impact on the environment from a product by holding manufacturers (producers) liable for the take-back, the recycling, and for final disposal of the products, thus for the entire life cycle. EPR is executed by means of informative, administrative and economic instruments. The configuration of these instruments governs the precise form of the EPR (Lindhqvist, 2000:37). The Organisation for Economic Co-operation and Development (OECD) summarises the goals of EPR as:

- Reduction at source, such as natural resources and materials conservation.
- Prevention of waste.
- Product designs, which are more environmentally friendly.
- Promotion of sustainable development by closing the material loops (OECD, 2001:29).

In Switzerland two associations developed EPR systems to ensure the e-waste is effectively managed within the country, S.EN.S (Swiss Foundation for Waste Management) and SWICO (Swiss Association for Information, Communications and Organization Technology) (Streicher-Porte, 2006:281).

Policies on EPR had been introduced in European countries to achieve waste minimisation. Producers are accountable for the management of the environmental effects of their products from production throughout the entire life cycle of the products. This made producers responsible for the management of their products from the production phase until the end of life of the product. This legislation transfers responsibility away from local authorities, taxpayers, and consumers to the producer (Gottberg *et al.*, 2006:39).

To manage waste that requires special treatment and handling, legislators are progressively implementing EPR policies. Examples are e-waste and discarded cars. In Table 2.2, a few of the possible EPR approaches as suggested by the OECD (2001) are reviewed. These range from voluntary to mandatory EPR systems. A mandatory take-back system is one where a seller of a product must take back at least a similar product that was sold to a customer if the customer wants to return the EoL item. Widmer *et al.* (2005:446) assert that voluntary take-back approaches are preferred to mandatory methods to implement EPR strategies. The reason for this is primarily to avoid the development and implementation of national laws and regulations.

The opinion of Panambunan-Ferse and Breiter (2013:224) is the opposite from that of Widmer *et al.* (2005:447). They argue that the lack of a mandatory take-back system caused producers in some EU countries to perform poorly. This underlined the important role of regulation in Europe. In South Africa, no system exists for e-waste management focusing on household e-waste and products are mainly imported. Household goods rank among the highest imported (In dollar value) goods with Cellular phones (No 4), Computers (No 6), Televisions and radio's (No 47), Fridges and freezers (No 66), Dishwashers (No 68), and Air conditioners (No 83) (Workman, 2019). Many of the originating countries, such as the European Union and Japan, have e-waste management programs in place but the lessons learnt have not yet been transferred to South Africa. To initiate such a system effectively, mandatory systems seems to be suitable. Just as a lack of proper regulation in European countries caused poor performance, one can safely assume that the same situation exists in South Africa. This will only be addressed through a mandatory system.

Table 2.2: Examples of possible approaches for EPR systems

Type of EPR approach	Examples
Programmes for product take-back	• Take-back which is mandatory • Take-back programmes can be voluntary or negotiated
Regulatory methods	• Minimum standards for product • Exclusions of some hazardous materials or products • Bans on disposals • Recycling which is mandated
Voluntary practices from industry	• Codes of practice which are voluntary • Private and public partnerships • “Servicing” and Leasing • Labelling
Use of economic instruments	• Deposit–refund schemes • Advance recycling fees • Fees on disposal of items • Material taxes and subsidies

Source: Widmer et al., 2005:447

Producers around the world are involved in the recycling of e-waste. EPR or some form of producer responsibility programme is used in countries, which are more effective in dealing with WEEE. An e-waste management system for South Africa is thus needed to recycle and dispose of e-waste effectively. Although EPR is a single concept, implementations differ around the globe.

2.5.3 Stakeholder responsibility

Aizawa, Yoshida and Sakai (2008:1399) stated that the Japanese law on WEEE clearly stipulates the roles of all participants in the e-waste recycling chain. At the time of disposal, consumers must pay for recycling, retailers must collect items from consumers and transfer them to manufacturers, and manufacturers (including importers) must recycle the items.

By introducing a manifest system, authorities and consumers can monitor the discharged waste to determine if the e-waste was transported correctly and recycled. This is to ensure that waste from home electrical appliances is taken to retail stores by the consumers from where it will be delivered to manufacturers for recycling. Collection by retailers in South Africa would be very problematic as legislation for this is not in place and retailers would claim that transport is not their core business. In Japan, the transport is done to manufacturers, whereas in South Africa there are few manufacturers as household appliances are mainly imported.

The Environmental Protection Administration of Taiwan (EPAT) created a recycling programme called the 4-in-1, which consisted of a recycling fund to pay for the recycling, municipal collection, residents from the community, private collectors and recyclers (U.S. EPA, 2012:7). The stakeholder and their roles are as follows:

- **Community residents:** When residents take their waste to municipal collection points it has to be separated into organic wastes, recyclable waste and non-recyclable waste.
- **Collectors and recyclers:** WEEE, which is part of Regulated Recyclable Wastes (RRW), is bought from residents by collectors and private recyclers. In this way, revenue is generated from these wastes and resources are recovered.
- **Local Governments:** RRW and other wastes are collected by collection teams from community collection sites by local governments and municipalities. The municipal solid waste, which has value and RRW are sold to private recyclers and a share of the revenue is given to local government who will then maintain and upgrade community waste collection sites.
- **Recycling Fund:** This fund subsidises the collection of municipal RRW, and that of private collectors and recyclers. The collectors and recyclers must meet the environmental and safety standards of EPAT. The manufacturers and importers of new RRW products, which include EEE, must pay recycling fees to EPAT relative to the new items placed on the market under the 4-in-1 recycling programme. The Recycling Fund Management Board (RFMB) then manages the Recycling Fund fees.

In 2003, the EPR law came in effect in South Korea (Kahhat *et al.*, 2008:957). Local manufacturers, distributors and importers of consumer goods had to comply with official recycling targets or pay penalties. Air conditioners, televisions, and personal computers (PC's) are examples of EEE. The recycling funds must be deposited into a government

account. Depending on the actual recycled waste volumes, the funds would be paid proportionally. To meet their own EPR requirements, local manufacturers and importers can institute their own recycling facilities or else it can be outsourced to professional recycling companies or to industry associations. If customers buy similar products, the used equipment must be collected and transported freely by retailers and suppliers. At the time, the manufacturers paid a recycling fee ranging from US\$ 4 to US\$ 17. The collection fee is the responsibility of the consumers, who have two options: (1) if the consumer buys a replacement item no collection fee is payable and retailers must collect the e-waste, or (2) paying a collection fee to the local government collection system when buying a new product; this fee is around US\$ 8 to US\$ 10. In the case of PC's, a free collection of the e-waste is offered by some companies.

According to the World Consumer Income and Expenditure Patterns (2013), South Africa is a low-income country with a yearly disposable income per capita of 6323 USD (+- R93 000 in 2019), has an unemployment rate of 24.4%, and 50% of the population lives below the poverty line. Due to the poverty in South Africa, residents could be negative about a recycling fee, seeing that no fee has been paid in the past. A plastic bag-recycling fee has been collected by the South African Government, however this unfortunately resulted in millions of Rands being paid into a Government registered section 21 company but "there is very little to show for it" (Fish, 2011). For more than a decade, more than R1.2 billion has been collected from plastic bag taxes but no jobs were created for the youth in the green industry as was meant to be (Chothia, 2016). The inability of the Government to apply collected recycling fees effectively could result in resistance from consumers and consumer representative bodies. The possibility of having a recycling fee being paid into a South African Government account thus needs to be investigated as well as the method of collection of a recycling.

Countries with some form of WEEE management programme define the roles and responsibilities of the different stakeholders. The result is that clarity of procedures, financial obligations, and target rates exist between stakeholders and contribute to a cohesive environment for effective WEEE management.

2.5.4 Systems coverage and ensuring compliance

In the European member states, private household WEEE is categorised into two compliance categories. The first compliance scheme is categorised as a “competing collective system” with more than one compliance scheme handling the same category WEEE in competition, and the second compliance scheme is categorised as a “single national compliance system” if there is no competition (Sander *et al.*, 2007:97).

Sander *et al.* (2007:98) indicated that countries such as Belgium, the Netherlands, Sweden, Norway and Switzerland (the last two are not EU member states) had some form of legislation on e-waste even before the WEEE Directive was implemented. These countries made use of a Single National Compliance system, in which all e-waste products were covered. Producers or trade associations together initiated the practical arrangements to take back WEEE and have it recycled for their members. For these countries, this is the only collective compliance option available although there is competitive tendering for transport, pre-treatment, and recycling services. The competitive approach is followed by countries such as Italy and Germany due to producers being opposed to monopolistic compliance schemes and with the tendency of single national compliance systems to accumulate large sums of money for future WEEE treatment. In 2007, there were 76 compliance schemes and close to 40 000 registered producers in the EU countries (Sander *et al.*, 2007:206). In the past few years, some of these compliance schemes were combined, e.g. nine compliance schemes formed a joint venture in 2015 (Waste Management World, 2014).

System Design 1:

In this system, a single compliance organisation or Producer Responsibility Organisation (PRO) manages the take back, collection, and recycling obligations on behalf of producers. The scheme coordinates the infrastructure for collection and recycling. Individual producer collections are not acknowledged as part of the required obligations.

System Design 2:

This compliance system or PRO is similar to the Systems Design 1, but individual producer collection efforts (own-brand or mixed brand) are acknowledged towards its required obligations.

System Design 3:

Various compliance schemes or PRO's are operating nationally. Required obligations are not met by collection efforts (own-brand or mixed brand) from individual producers. The collection infrastructure is developed by the different producers by contracting directly with retailers and/or municipal collection sites.

System Design 4:

In this design system, there are also various compliance schemes or PRO's operating nationally. Collection efforts (own-brand or mixed brand) by individual producers are acknowledged and the multiple compliance schemes are running in parallel.

Producers in Japan are deeply involved with the processing of e-waste and this has shown a strong design for environment (DfE) feedback. DfE implies that products are designed by taking recycling and environmental impact into account. This is especially true for the recovery and use of plastics and in the ease of dismantlement of products. The disadvantage of this approach is that the prevention of hazardous materials and a reduction of energy usage should have the higher priority, which is not the case. Comparing this with the EU, the producers are not focusing on recycling itself. Contracts are negotiated with specialised recycling companies by producers on an individual basis or as part of members of the joint scheme. The cost competition between companies works well with this arrangement. The DfE feedback in this case is rather weak, but more attention is given to the hazardous substance regulations (RoHS) and the energy-using product directives (Yoshida & Yoshida, 2010:25).

In the Japanese system for recycling e-waste, the manufacturers have a direct physical obligation to ensure that e-waste gets recycled compared to the European situation where EU manufacturers rather have a financial obligation to recycle e-waste (Aizawa, Yoshida, & Sakai, 2008:1400).

Different WEEE systems designs are used around the world. The ultimate aim of these systems is to ensure there is compliance by all affected stakeholders and in particular the producers. Different systems designs have shown the emphasis to shift between DfE in the Japanese system, whereas the EU producer system focuses on the financial obligation to recycle e-waste. In the South African scenario for household e-waste, the

method to cover the systems and to ensure compliance needs to be determined. The pre-emptive approach to introduce legislation in Belgium, the Netherlands, Sweden, Norway and Switzerland, before EU directives were promulgated is showing results (See Table 2.1) as the EU is a fore runner where efficiency of e-waste recycling is concerned. Dedicated e-waste legislation thus seems to be a first step for effectiveness.

2.5.5 Registry of E-waste

Producers are defined on European, national and local levels because sometimes manufacturers are, or are not, in the EU. Producers could be wholesalers, distributors, retailers, etc., depending on where they fit into the retailing chain. What is of importance however is that producers must clearly mark the products to identify themselves. The producers of EEE must also have important information (e.g. hazardous content) on the products for the treatment facilities (Sander *et al.*, 2007:VIII). The reporting of EEE figures are done differently in member states and could be monthly, quarterly, or biannually to annual reporting periods. Furthermore, a product is seen to be “put on the market,” and must subsequently be reported to a national registry, if the raising of Value Added Tax (VAT) occurred in the financial transaction (Sander *et al.*, 2007:X). Distance sellers of EEE have to either register in the member states where the EEE is exported from, and they must supply export figures to the authority of the export member states or they must register in the member states to where the products are exported. Some member states make use of both methods, whilst others do not require any registration at all (Sander *et al.*, 2007:VI).

A registry is a method of keeping track of what is placed on the market, and from where the products originate. In the South African context, the household appliances are mainly imported with a few products being manufactured locally. By keeping a registry, the numbers and weights of EEE being placed on the market are traceable. Producers can be involved with a recycling system based on their EEE production into the market, recycling figures can be calculated, and recycling targets can be set. The need for a registry, the administration, and the upkeep of such must be investigated as it could contribute to effectively managing an e-waste system.

2.6 E-WASTE LEGISLATION AROUND THE GLOBE

2.6.1 Introduction

Empirical research offers diverse views regarding the role and impact of legislation on e-waste. Argument, Lettice and Bhamra (1998:76) examined the design of environmentally conscious products from the perspective of industrialists and academics. It was found that some companies would act proactively towards legislation, while others acted reactively. The former group preferred to stay ahead of new legislation and thus promoted an in-depth study towards more environmentally friendly designs. The findings revealed that consumer demand and preference could influence eco-designs, but legislation was perceived to be far more influential (Argument, Lettice, & Bhamra, 1998:76). It was therefore concluded that the biggest industrial influence is achieved through legislation.

Some experts are opposed to legislation and argue that the competitiveness of businesses would be negatively affected with the introduction of environmental regulation; however, this has been not empirically proven. Gottberg *et al.* (2006:45), for example, suggest that WEEE competitors are affected equally by the environmental policy of a country. Andiç, Yurt and Baltacioğlu (2012:50) similarly found that legal and economic drivers are the most significant incentives for ecological responsiveness. These empirical results thus suggest that legislation could have a significant industrial and environmental impact when dealing with e-waste.

2.6.2 E-waste legislation in Asian countries

- ***Japan***

A law promulgated by the Japanese Ministry of Health and Welfare in 1999 required that iron, copper, aluminium, and glass from Cathode Ray Tubes (CRT's) must be recycled and fluorocarbons, such as chlorofluorocarbons, hydrochlorofluorocarbons, and hydrofluoro-carbons, must be collected from refrigerators and air conditioners (Aizawa, Yoshida, & Sakai, 2008:1403). The Japanese Specified Home Appliances Recycling Act published in 1998, came into effect in April 2001. Collection, transport and mechanisms to recycle WEEE were specifically stipulated, but the act covers only air conditioners, TVs, washing machines and refrigerators, and recycling is the responsibility of producers.

If producers do not comply with the recycling rate targets, hefty penalties are imposed (Widmer *et al.*, 2005:449). It is important to note that a recycling fee is requested from consumers in the Japanese recycling system for consumer equipment when it is returned. This fee is then used by producers to recycle e-waste or when they discard any one of the four equipment types mentioned. The law also states that retailers must take back WEEE (Yoshida & Yoshida, 2010:22).

- **China**

Researchers of the e-waste sector in China are of the opinion that before the introduction and enforcement of laws and the formulation of satisfactory policies and regulations, it was almost impossible for a legitimate WEEE recycling company to run effectively (He *et al.*, 2006:511). A warning was given that India had tried to implement e-waste legislation without success and China had limited e-waste legislation with no clear direction. This was due to the large populations of the two countries, which would see a sharp increase in electronics equipment sales, in turn contributing to the growing mountain of 40 million tons of e-waste per year (UNEP, 2009:65-66). Zeng *et al.* (2013:81) summarise the Chinese legislation, pertinent to e-waste, which came into force since the UNEP report:

- In 2007, the Ordinance on Management of Prevention and Control of Pollution from Electronic and Information Products (new China RoHS by Ministry of Industry and Information Technology) came into force.
- In 2008, the Administrative Measure on Pollution Prevention of Waste Electrical and Electronic Equipment's was adopted. The aim of the legislation was to avoid severe pollution and to decrease source pollution produced in the informal sector from 2000 to 2006.
- The State Council passed the Administration Regulation for the Collection and Treatment of Waste Electric and Electronic Products (China WEEE regulation by National Development and Reform Commission and Ministry of Industry and Information Technology) at the same time. The legislation was only implemented on January 1st, 2011, due to an unexpected financial crisis, which hit China.
- Before the China WEEE regulation was introduced, a temporary policy was introduced to manage end-of-life household appliances. The regulation specified the appliances as computers, air conditioners, televisions, washing machines and refrigerators. The regulation was introduced to ensure that collection and treatment were properly done for the bulk e-waste. The system was called the "Old-for-New" Implementation

Measures for Household Appliances (State Council). The regulation came into effect from June 1st, 2009, and ended, after an extension, on December 31st, 2011. At the end of November 2011, the total collected quantity was 83.73 million tons, and at the end of December 2011, the total sales were 92.48 million tons for the five types of household appliances. A weight of 66.21 million tons was dismantled and the total quantity of steel, iron, plastics, and non-ferrous metals recovered amounted to approximately 970 000 tons (Zeng *et al.*, 2013:82).

The implementation of laws and regulations in China shows a dedicated strategy to address e-waste specifically, as well as some successes after implementing measures.

- **Indonesia**

Indonesia, with a population of 240 million, has no regulation on national or regional level to manage the generated household e-waste. The EPR approach has been adopted by the Indonesian Central Government since 2008, but at the time of the study, they were still busy with the drafting of the regulation. The situation was still unchanged in 2016 (Yoshida *et al.*, 2016:49). The focus of the National Government was more on preventing the illegal e-waste importation to remote islands and Indonesian ports (Panambunan-Ferse & Breiter, 2013:226). The absence of e-waste regulation in Indonesia contributed to a low return of cell phones, as well as a low collection rate of other ICT devices (Panambunan-Ferse & Breiter, 2013:229).

- **South Korea**

Four types of home appliances are regulated in South Korea together with that of packaging materials under the Act on the Promotion of Saving and Recycling of Resources (APSRR) promulgated in the 1990s (Manomaivibool & Hong, 2014:203). TVs and washing machines were regulated from the start, air conditioners from 1994 and refrigerators from 1997. APSRR introduced a producer-based deposit refund system called DRS in 1992, which was a system in which the producers paid deposits to a State fund who gave the refunds based on the amount the producers recycled. The use of economic instruments was replaced by mandatory responsibilities when the law was revised in 2002. APSRR was revised in 2002 as part of the 2nd Comprehensive National Waste Management Plan (2002–2011) to change its policy instrument. A mandatory EPR system replaced DRS. In addition to the four large home appliances, PC's were added to

the programme in 2003, followed by mobile phones and audio equipment in 2005, and printers, copying machines and fax machines in 2006 (Manomaivibool & Hong, 2014:204). APSRR was amended again in 2008 to promote the preferred re-use and material recovery as opposed to energy recovery. The Act for Resource Circulation of Electrical and Electronic Equipment and Vehicles was enacted on 29 February 2008, with the objective of contributing to the healthy development of a national economy and the conservation of the environment; the new system was called the Eco-Assurance System or EcoAS (Manomaivibool & Hong, 2014:206-207).

- ***Taiwan***

According to the United States Environmental Protection Agency (U.S. EPA) (2012:6), Taiwan has EPAT that regulates and ensures effective recycling of e-waste. The Waste Disposal Act of 1979 was amended in March 1997 and required resource recovery and recycling for RRW and for selected municipal solid waste. This was the start of EPAT's recycling efforts. EPAT introduced the "4-in-1 Recycling Programme," which ensures participation of importers of new RRW products, manufacturers, municipal collection teams, community resident teams and recyclers, into an integrated system. Recycling of RRW, including WEEE, is done and funded from a fee-and-subsidy system, which is operated by EPAT's RFMB fund under the 4-in-1 Recycling Programme. In 2002, standards were distributed in Article 18. Under this article of the Waste Disposal Act, the collection, storage and recycling of e-waste must follow the safety and environmental standards of EPAT. The standards were revised in 2007 (U.S. EPA, 2012:15).

Asian countries such as Japan, China and South Korea started their e-waste initiatives similarly by specifying refrigerators, televisions, washing machines, and air conditioners as the priority items for recycling. It was also noted that different financial regulation measures were used by some of the countries and that legislative and administrative measures were implemented in China to regulate e-waste after an initial lack of dedicated e-waste regulation.

2.6.3 E-waste legislation in Europe

- **Switzerland**

Switzerland is a pioneer in European countries where legislation regarding e-waste management is concerned. The Swiss Federal Office for the Environment introduced laws on e-waste management in 1998, through the Ordinance on "The Return, the Taking Back and the Disposal of Electrical and Electronic Equipment". PROs using voluntary initiatives started formal collection and management of WEEE even before the legislation came into place (Khetriwal, Kraeuchi & Widmer, 2009:159).

In Europe directives were drafted, and mandated the adoption of an environmental approach to the designs of manufacturers and stakeholders. The first Directive was the RoHS Directive 2002/95/EC, the aim of which (European Union, 2003a) was to limit the use of some hazardous substances in newly designed electrical and electronic equipment (EEE) and to limit the environmental impact of EEE when it reaches the EoL stage.

The second important Directive was the WEEE Directive 2002/96/EC, which requires EU member state importers and manufacturers to take back their products from consumers (European Union, 2003b). They must also ensure that e-waste is disposed using environmentally sound methods. The priority of this directive was to prevent the generation of WEEE, and to promote the re-use, recycling and recovery of e-waste in order to limit the disposal of waste. The collection targets based on previous sale volumes were also adopted in the recast of the WEEE Directive. Instead of the four kg per capita target, a new Directive 2012/19/EU required the member states to achieve a collection rate of 45% by weight of EEE placed on the market in three preceding years by 2016 (Manomaivibool & Hong, 2014:203).

European legislation sets targets on collection and recycling of general WEEE, but there is no specific collection targets for EoL for mobile phones. Mobile phones are highlighted by Polak and Drapalova (2012:1583-1584) and it is most probably due to the fact that 600,000 litres of water can be polluted by the cadmium from one mobile phone battery (He *et al.*, 2006:503).

The EuP directive 2005/32/EC is the third important directive (European Union, 2005). This directive established a framework to ensure that a free movement of energy using products was possible within the internal EU market. Energy-using products have eco-design requirements set by the directive and by means of the directive, the energy efficiency is increased, the environment is protected, sustainable development is achieved and the security of energy supply is increased.

The EU WEEE Directive was implemented in Germany by the legal Act Governing the sale, return and environmentally sound disposal of electrical and electronic equipment (Germany, 2005).

When it comes to WEEE take back systems, the European Union is leading the way in terms of procedures being laid down and with legislation, but EU Directives still have to be incorporated into member states (Ongondo, Williams, & Cherrett, 2011:717). Although the EU has developed wide-ranging WEEE directives for EU members that will have far-reaching affects outside of European borders, there are shortcomings. There were criticisms on the clarity of the directives and transpositions into member country legislations (Ongondo, Williams, & Cherrett, 2011:726). Member states had until February 2014 to incorporate the WEEE directives into national law (IPA, 2019).

The EU introduced various directives to guide the member states in restricting the use of hazardous substances, taking back WEEE, and setting requirements for energy-using products. Even with these directives, there are still shortcomings on the collection of mobile phones and criticism regarding the clarity and transposition of the directives into member states.

2.6.4 Legislation in United States of America (USA) and Canada

In the USA, legislative activity has rapidly increased over the years. In 2006, 54 bills were introduced in 27 states and in the following year, 79 legislative bills on e-waste were introduced in 33 states. There was also an increase in e-waste legislative activity over the preceding years. Electronics recycling systems have been created through approved legislation as from September 2008. This occurred in four Canadian provinces and 17 US states. These efforts are praiseworthy although many of the laws were introduced

simultaneously without the benefit of learning from current systems. Policymakers and system architects were in an undesirable position, as they had to develop systems by experimenting with what would work. New policy instruments were thus not well tested. The unavoidable result was that the e-waste take-back systems in many states and regions were a patchwork of different applications (Solving the E-Waste Problem - White Paper, 2009:5). Although no national law exists in North America, states, provinces and cities have implemented various measures to divert display and computing devices from landfill and promote their reuse and recycling, including imposing convenience standards, high collection targets, quality rewards and/or underachievement fines (Manomaivibool & Hong, 2014:203).

Oliveira, Bernardes and Gerbase (2012:1598) showed that 25 states in the USA had some form of either PRO programmes, consumer fee laws or other models for recycling.

Although more than half of all US states and Canadian provinces accepted legislation governing the management of e-waste between 2003 and 2010, there are two predominant commonalities in all the legislative rules. Firstly, the legislation assumes that it is an undeniably management problem of post-consumer e-waste. Secondly, legislation was promulgated with the assumption that the solution to the problem was to organise a management system using the EPR approach. Manufacturers have to bear the financial and/or physical duties for the management of EoL electronics. It was claimed that an EPR system would convince manufacturers of EEE to take on the costs of managing the negative nature of post-consumer e-waste and thus steer manufacturers in a direction where they design and manufacture green(er) products. The same author was of the opinion that because the e-waste laws in Canada and the USA are not promulgated by their respective federal governments, but rather by provincial and state jurisdictions, the financial responsibility for e-waste management would be delegated to consumers and not to producers. This will defeat the aim of steering manufacturers in a direction where they design and manufacture green(er) products (Lepawsky, 2012:1194).

Lepawsky (2012:1195) indicated that the American and Canadian e-waste systems covered seven different types of e-waste, which included monitors, printers, computers, TV's, DVD's, peripherals (keyboard, mouse), and CD players. All six of the Canadian states covered all of the mentioned e-waste types, while only Wisconsin and New York

State covered all seven; the other USA states involved covered some of the e-waste types.

In summary, E-waste legislation has been introduced in the USA and Canada on provincial and city levels. Legislation is changed through experimenting and learning experiences. Compared to Japan, China and South Korea, the focus of the USA and Canadian WEEE efforts is on the smaller e-waste equipment whereas the Asian countries focus on the bigger and heavier white goods, which includes televisions, air conditioners, washing machines, and refrigerators, as their priority items for recycling.

2.6.5 Legislation in developing countries

- ***The Summers memo***

In 1991, Larry Summers advocated that it made economic sense to export waste from first world countries to developing countries. At the time, he was the Chief Economist of the World Bank and later became president of Harvard University. His rationales were that:

- Recovering of costs from countries with the lower salaries would be minimal when there was an increase in mortality and morbidity and they would lose the least productivity.
- Africa, with the least developed countries, was far lower polluted than first world countries and could gain by implementing schemes for trading in pollution. They thus have water and air to spare.
- It is a luxury for the rich to get environmental protection focused on aesthetics and for health reasons. He argued that these developing countries already have a large death rate and that mortality due to pollution would be small in comparison to their existing problems (Widmer *et al.*, 2005:438).

- ***Basel Convention***

The 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal came into force on 5 May 1992. This is the most prominent example from the international community to counter thinking of this sort, e.g. Larry Summers. America was the only industrialised country in the world that was not a signatory to this convention (Widmer *et al.*, 2005:438). Although the United States has

since became a signatory to the Basel Convention it has still not become party to the Convention (EPA-International Agreements on Transboundary Shipments of Hazardous Waste), (UNEP, 2011a). The result is that hazardous e-waste is still exported from America to countries where there are less health and environmental safety laws. An investigation tracked waste electronics and found them ending up in China, Canada, Dominican Republic, Kenya, Mexico, Pakistan, Taiwan, Thailand, and rural Hong Kong (Puckett, 2016).

The main objective of the Basel Convention is the protection of the environment and that of human health against the negative effects of wastes that are hazardous. The Basel Convention has the following primary aims:

- The promotion of environmentally sound management principles to address disposal of hazardous wastes irrespective of the place of disposal, and to reduce the generation of hazardous waste in products.
- Limiting movements of the hazardous wastes over country borders, except if it is done in agreement with environmentally sound management principles.
- Where transboundary movements are allowed, the regulatory system must be in place (UNEP, 2011a:5).

- ***Bamako Convention***

To address shortcomings in the Basel Convention, African countries created the Bamako Convention for complete banning of hazardous substances, such as e-waste. The Bamako Convention is an instrument that controls the movement of hazardous wastes across national borders of countries. The purpose is to prevent developed countries illegally dumping waste in developing countries (Webster, 2002:66).

Government attitudes, the implementation of EPR, development of legislation pertaining to e-waste, the prevention of the dumping of e-waste, and the transfer of knowledge and technology to recycle e-waste effectively are some of the key principles needed to manage e-waste efficiently in developing countries (Nnorom & Osibanjo, 2008:843).

- ***Mercosur Policy Agreement***

Latin American countries have some form of national and regional laws. Regionally, the Mercosur Policy Agreement from 2006 dictates that member states such as Brazil,

Paraguay, Argentina, and Uruguay take steps on a national level to ensure that producers and importers take responsibility for post-consumer waste. This agreement anchors the concept of EPR as a policy principle to protect the environment on a sub-regional level. The Organization of American States (OAS) has stated a willingness to avoid and lessen the damaging effects related to ICT waste during the life cycle of the product, and more specifically is focused on the inadequate recycling techniques. This was done in the Santo Domingo Conference in 2006 (Boeni, Silva, & Ott, 2008:668).

As part of legislation, and in a drafted decree on WEEE, the Costa Rican Government stipulated EPR as a policy principle on a national level. The effective management of e-waste from ICT is the responsibility of producers. A public-private committee was to be instituted who would set up goals to implement the decree. At the time, only categories 3 and 4 (ICT and Consumer Electronics WEEE) were incorporated. Argentina started a national plan on the management of e-waste in 2005, and in 2006, a project on specific legislation was started to cover the 10 WEEE categories mentioned in the European Directive. A third project was initiated in 2007 to propose principles that would guide companies working in e-waste management. At the time, the political support to implement the proposals was lacking and thus it could not be implemented. In Brazil, some EPR-based laws were introduced on state level, but there were still some contradictions between state and federal level. In Sao Paolo, there seemed to be strong opposition from the producers to incorporate EPR as a guiding principle for WEEE management; on the federal level, there was also opposition. In Peru, there was a discussion to include the EPR principle while the national waste legislation was revised. In Colombia, a draft framework for the legislation of WEEE was on the political agenda (Boeni, Silva, & Ott, 2008:668).

Many Latin American countries are lagging behind in the promulgation of framework legislation to manage e-waste. The roles of both industry and government need to be made clear before the drafting of legislation. A prerequisite to achieve an implementable and successful legal framework is that there should be participation from various stakeholders (Boeni, Silva, & Ott, 2008:671).

Since 2008, the situation has not changed drastically as no Latin American countries have an inclusive e-waste management system. The management of e-waste is done by

informal collectors who added household e-waste to the existing collection of solid waste or the refurbishment of products for reuse. A recycling industry has since developed to recover high value materials such as gold, silver and copper; the problem is that this occurs while no refined technological processes exist (Oliveira, Bernardes & Gerbase, 2012:1603).

In India, the Ministry of Environment and Forests issued rules and guidelines for the management of waste. The applicable e-waste are the 2004 “Municipal Solid Waste Management Rules” and the 2008 “Hazardous and Waste Management Rules.” In 2012, new regulations came into effect and codified as the “2010 E-waste Management and Handling Rules.” The purpose of the rules is to set limits on the hazardous substances in the six RoHS materials. There was also a call for EPR rules for recycling as well as for collection centres (Sthiannopkao & Wong, 2013:1151).

The importing of e-waste into India is considered illegal, according to judicial ruling. The rules are however ineffective as it can easily be sidestepped by making use of loopholes in the system. E-waste is mislabelled as scrap metal, donations to charities or products that can be re-used (Manomaivibool, 2009:141).

Some developing countries have some form of legislation. From the literature, it is evident that the Latin American countries have no robust and inclusive management system for e-waste. Although India has some form of legislation, these laws are easily evaded.

From the literature it is clear that global legislation around e-waste is sometimes effective, sometimes non-existent, sometimes poorly regulated. The common factor is that legislation (or lack thereof) is different all over the world. Mistakes being made as well as successes should be investigated by the South African law makers while this will only be achieved through inputs from various stakeholders in the South African e-waste scenario.

2.7 COLLECTION ARRANGEMENTS OF E-WASTE

2.7.1 Composition of e-waste

WEEE consists of 10 categories as listed in Table 2.3. This was defined by the European Parliament and the Council (January 2003) on Waste Electrical and Electronic Equipment (European Union, 2003b) in The Directive 2002/96/EC.

The Swiss 'Ordinance on the Return, the Taking Back and the Disposal of Electrical and Electronic Equipment' accepted the same categories in June 2004, as specified by the Directive (Widmer *et al.*, 2005:439).

Table 2.3: EU Directive on WEEE – Specified WEEE categories (Forti, Baldé & Kuehr, 2018)

No.	Category	Label
1	Household appliances - Large	Large HH
2	Household appliances - Small	Small HH
3	Telecommunications and IT and equipment	ICT
4	Consumer equipment	CE
5	Lighting equipment	Lighting
6	Electrical and electronic tools (Large-scale stationary industrial tools excluded)	E & E tools
7	Toys, leisure and sports equipment	Toys
8	Medical devices (All implanted and infected products excluded)	Medical equipment
9	Monitoring and control instruments	M & C
10	Automatic dispensers	Dispensers

2.7.2 Collection, number of collection points and efficiency of collection

- **Germany**

Before the ElektroG was implemented in Germany, the public waste management authority (PWMA) of an area used to collect discarded electronics. Recycling was done by an independent contracted disassembly or recycling company, which could process

all types of electronic products. It was common practise to have longstanding supply agreements between disassembly companies and PWMAs (Walther *et al.*, 2009:465).

After the ElektroG was implemented in Germany, take-back systems were initiated to collect e-waste. The responsibility of producers was expanded to include the treatment and discarding of EoL electronic devices. Disassembly contracts were centralised by producers or even consortia of producers. The PWMAs in Germany still collect WEEE but, contradictory to the WEEE directive, grouped e-waste into five categories, which are sorted by the PWMA at the collection point. The pick-up process, the control of the collection, recovery and recycling targets, is done by the Foundation Elektro-Altgeraete-Register. Collection is done when at least 30 m³ of one of the e-waste groups has accumulated at the PWMA. EAR sets the criteria to determine which producer must pick-up the e-waste, treat the collected e-waste and provide a new container to collect e-waste again. These tasks are normally outsourced to a commissioned service provider (Walther *et al.*, 2009:466).

From a report on producer responsibility compiled by Sander *et al.* (2007:III), it is shown that out of 27 member states in Europe, collection of household WEEE is done by the following methods: in 18 countries, the collection is done through the distributor of EEE; from the same 18 countries, 11 are also using municipalities for collection and 10 are using producers to do the collection; out of the 27 countries, six are using producers for the collection and the remaining three use municipalities for household collections.

Sander *et al.* (2007:141) indicated that in Ireland there are two compliance schemes, EPR Ireland and WEEE Ireland. In 2017 WEEE Ireland collected 10.08 kg of e-waste per head of the population (WEEE Ireland, 2017).

- **Japan**

In some countries, municipalities collect and perform processing operations for recycling, which is not the case in Japan. Panasonic, Toshiba, Mitsubishi, and Hitachi formed a producer partnership system and are responsible for the collection and processing of e-waste. The collection targets for the four recyclable e-waste items are set by the Japanese government (Yoshida & Yoshida, 2010:22).

Even though recycling fees were collected in Japan by nine large retailers with estimated sales of one trillion yen, six retailers have been caught not transporting collected appliances. The appliances were either sold to re-use dealers or illegally entrusted to waste dealers. Some received the recycling fees from their customers but still re-sold the appliances to re-use dealers; others illegally entrusted the appliances to waste dealers (Aizawa, Yoshida, & Sakai, 2008:1407).

Japan's e-waste recycling system focuses pertinently on recycling and the policy does not address the re-use of items. It has been pointed out however that retail stores have taken back around 17.2 million units from an estimated 22 million units. From the 17.2 million units, only about 11 million units ended up at the recycling facilities of producers, the rest disappeared in an "invisible flow." Another 6 million discarded appliances entered into streams that are not part of the Japanese system. An outstanding fact is that is that the collection rate of products other than those specified in the Japanese Home Appliances Recycling Act is very low. Less than 10% of the discarded PCs were recycled and the take-back rate in 2006 of cellular phones was no more than 15% (Yoshida & Yoshida, 2010:22).

- ***Comparison between Switzerland, Denmark, Japan and India***

Widmer *et al.* (2005:448) compared the effectiveness of the WEEE systems in four different countries, namely Switzerland, Denmark, Japan and India. Although the scaling of the "Rate of return targets" was done on a subjective basis it was clear that Japan, with only four items that are part of the Japanese Specified Home Appliances Recycling Act, had much higher return rate target compared to the other countries (Widmer *et al.*, 2005:448). It was however pointed out that that the manufacturers' physical responsibility for WEEE in Japan is in contrast to the financial responsibility assigned to EU manufacturers (Aizawa, Yoshida, & Sakai, 2008:1401).

In 2010, Japan had a per capita collection rate per year of 3.5 kg for the four categories of collected e-waste. Norway, Switzerland, and Sweden had figures of 13.41 kg, 11.44 kg and 12.2 kg collection per capita per year respectively, with the Czech Republic, Estonia, and Slovakia having collection rates of 0.33 kg, 0.63kg, and 0.66 kg collection per capita respectively, contributing to a lower average of 5.31 kg per capita for the European countries (Yoshida & Yoshida, 2010:23).

- **Indonesia**

In Indonesia, a limited number of people know of recycling centres or collection points as not a single cell phone was brought to a recycling centre in Manado. It was found that only two of 110 respondents had ever heard about collection centres. In the study, key actors interviewed reported there was a lack of recycle and collection awareness from cell phone users (Panambunan-Ferse & Breiter, 2013:228). The collection from centres was voluntarily, with the result that half-hearted efforts were made to reach out and inform customers of the initiative to return old devices (Panambunan-Ferse & Breiter, 2013:229). South Korea conversely, uses retailers as collection points and takes back WEEE when customers buy new EEE (Manomaivibool & Hong 2014:207).

Panambunan-Ferse and Breiter (2013:227) showed that 97% of cell phones that are no longer used are kept at homes (61%), given to relatives/friends (26%) or sold (11%). The low price of second hand cell phones, the perception that it is old-fashioned, cheap, and that the technology is outdated making people not interested in them anymore were cited as the reasons for keeping cell phones. Distributors and retailers in Indonesia are thus not involved at all with the collection of old or discarded cell phones, however reorganising collection arrangements between these intermediaries and consumers could help to build a bridge between producers and consumers.

- **China**

Empirical research revealed that legislation in China is not yet effective to deal with e-waste in the informal sector. Chinese informal e-waste economy is flourishing due to vast differences between income from rural and urban areas (Orlins & Guan, 2016:75-77). This creates a flow of second-hand electronic and electrical products from urban to rural areas. At the EoL stage, informal recyclers pay consumers better prices for their e-waste than formal recyclers. Informal recyclers will then refurbish and disassemble to distribute to formal recyclers, smelters and refineries. There is an unwillingness to accept government interventions, such as mandated pricing, as they fear job and income losses if e-waste was to be recycled using mechanical processes. The implication is that there often is a large gap between the actual practices and the intention of legislators. Review of legislation is thus needed to regulate informal recycling (Orlins & Guan, 2016:75-77). The study by Wang *et al.* (2017:301) confirmed that the selling of e-waste to informal peddlers is a barrier in the Chinese environment to effectively and formally recycling e-

waste. Convenient service and high prices being received from peddlers makes it hard for formal collectors to compete with them.

- **Taiwan**

In Taiwan, e-waste is collected through various methods. The collection channels of e-waste are through municipal collection sites, retailers, donations to charities who then sell the e-waste WEEE to licensed recyclers, and through private collection initiatives. The majority of e-waste is transferred to subsidised recyclers, some e-waste goes to the second-hand market, and some gets recycled informally. Recyclers belonging to the 4-in-1 Programme do not take part in the Taiwanese re-use market (U.S. EPA, 2012:20).

- **Brazil**

Brazil is characterised by two collection systems (Oliveira, Bernardes & Gerbase (2012:1605-1606):

- *Social organisation collection*: Donation of computers are done to social organisations such as the Meta Reciclagem, the Centre for Digital Inclusion project, the Computer Museum, the Centre for Waste Disposal and Re-use of Informatics, and the Computer Refurbishing Centre. The main objectives of these organisations are digital inclusion of all people and the principle to re-use products. In Latin America, the Centre for Digital Inclusion was created in 1995 as an NGO, and it became a pioneer in the movement to include consumers digitally.
- *Collection from manufacturers*: Products must be collected and distributed to the correct destination by manufacturers of products. Companies have different recycling systems. As with other countries, the biggest problem is that the majority of the population do not know about the recycling programmes due to poor advertisement of the collection systems. Recycling rates are not controlled or monitored and a collection system had been implemented by only a few manufacturers. Dell and Itautec-Philco are manufacturers who implemented such systems. Dell accepts and recycles its own brand of computer equipment free of charge, and consumers are not required to buy a new product. Dell would however recycle other manufacturer's equipment on the purchase of a new Dell product. The service is supported by collecting the obsolete equipment from the consumer's home or office. Although the public is almost unaware of it, Motorola has the ECOMOTO programme to take-back cell phones and batteries. Although there is a limited number, consumers can return their EoL devices to the

technical assistance service centres of Motorola. In some states, Nokia has some drop-off centres. São Paulo City has 12 million inhabitants and São Paulo State is the biggest economical state in Brazil; in this state Nokia has only four collection points to collect EoL devices.

- **USA**

With regard to cell phone collections in America, the EPA initiated the Plug-In to eCycling drive, with the intention to increase cell phone collection in the country by having participation between manufacturers, service providers and retailers. Manufacturers such as Motorola, Office Depot, AT&T, LG Electronics, Best Buy, Nokia, Samsung, Sprint, Sony Ericsson, T-Mobile, Staples, and Verizon Wireless all participated in this operation. Consumers located the drop-off points through the website of the EPA (Silveira & Chang, 2010:2281).

A USA study however found that consumers stored their non-functional, used, or old items before discarding them. Possible upgrade, re-use, or refurbishment is thus delayed leading to lower profitability when eventually returned (Sabbaghi *et al.*, 2015:305). In California, the Cell Phone Recycling Act (AB 2901) had a noteworthy and encouraging impact on cell phone recycling rates. In 2009, the recycling rate in California for cell phones was 27 percent, which was almost three times the national rate. At the same time, television recycling was very ineffective. The assumption is that it is due to poor publication and weak enforced of acts (Milovantseva & Saphores, 2013:15).

- **Denmark**

In Denmark, small WEEE, light sources and portable batteries can be placed in a small plastic bag/box, which is then placed on top of the household waste bin and collected with the residual waste (Bigum *et al.*, 2013:2373).

- **Spain**

In Spain, WEEE is collected with the rest of municipal waste during waste removal days (Queiruga *et al.*, 2008:181).

From the literature, it is clear that in the Japanese system, products that are specified to be recycled seems to be a success whereas products that are not specified by legislation have low collection rates. Some countries have collection facilities and dedicated collection methods, whereas others have limited facilities. Collection efficiencies and collection focus differ between countries. Collections are done by various initiatives around the world. These include take-back initiatives from retailers and producers, municipal collections, dedicated collection facilities, donation strategies, etc. In this research, it will be important to determine which collection methods would be most appropriate for South African e-waste consumers.

2.7.3 E-waste recycling collection programs from consumers

Different programmes can be implemented to deal with e-waste recycling collection, namely i) permanent collection facilities located with municipal hazardous waste collection programmes, ii) retail collection programmes, iii) pavement e-waste pick-ups, iv) non-profit or thrift retail collection, and vi) drop-off special events, which are one- or multiple-day events organised at non-permanent sites (Nixon *et al.*, 2009:102).

Drop-off special events are regularly (45%) used in the USA and it is the preferred method in rural areas. The date/s and collection point/s are announced as drop-off events in the media, and occur a few times per year (Kang & Schoenung, 2005:375). In small towns and sparsely populated municipalities in Finland, the municipalities or regional waste management companies inform local inhabitants of the practical arrangements before the collection dates, typically once or twice per year (Ylä-Mella *et al.*, 2014:42). Nixon *et al.* (2009:120) advised that pavement e-waste pick-ups were suitable in high-density communities that were prepared to pay higher prices for increased convenience.

2.8 FINANCING MODELS FOR RECYCLING E-WASTE

It would appear that if producers are financially responsible for the collection and recycling of e-waste, there are no apparent negative effects on competitiveness and business sales (Gottberg *et al.*, 2006:48).

In the EU, producers finance their own product costs for waste management. Collective agreements can be used to accomplish their responsibilities but they are not liable for the financial costs of other producer's e-waste. Producers must give a financial guarantee, as there is the possibility that a producer who is on the market today will be inactive at the EoL of their products; this is to ensure producers and society does not have to bare the recycling costs of producers that stopped operating. Member states that are part of a collective compliance scheme for new e-waste seem to have an appropriate guarantee to ensure recycling takes place. However if producers have recycling insurance or a blocked bank account they can individually fulfil the requirements of the guarantee. A financial guarantee is a requirement for all producers in Germany, Italy and Sweden. Germany however makes use of a collective financial guarantee, which means that producers in the market take on the responsibilities for products of producers that exit the market. To ensure a financial guarantee by setting up a limited brand or own brand compliance system, or the acquiring of either a blocked bank account or a recycling insurance is a more costly exercise as opposed to joining a collectively organised compliance scheme. As producers are exempted from setting aside a financial guarantee when joining a collective scheme, it is hindering many producers to develop an individual or limited brand compliance scheme (Sander *et al.*, 2007:V,VI).

From a report on producer responsibility compiled by Sander *et al.* (2007:III), it is shown that out of 27 member states in Europe, the financial responsibility for recycling fees for household EEE lies with the following stakeholders: for 15 countries the financing is done through the distributor of EEE and out of these 15 countries, nine also use producers for financing and four use municipal financing models; of the 27 countries, nine use only producers for financing and three only use the municipal financing system. From Sander *et al.* (2007:V), it is evident that even with the EU Directive on WEEE there are different interpretations and promulgated legislation on the financing of e-waste being placed on the recycling market after 13 August 2005. One group, consisting of 10 countries/provinces, legally requires producers to finance the recycling of e-waste generated from their own products that were introduced into the market after 13 August 2005. A second group, consisting of 11 countries/provinces, do not have legislation that assigns financial responsibility individually. In many instances, the responsibilities of producers are stated in the plural. This practice makes the interpretation unclear as to whether producers must bear the financial costs for their products after 13 August 2005.

In the same group, two countries give producers the option to elect for collective or individual financial responsibility for their products placed on the market after 13 August 2005. Irish producers who are members of an “approved body” are excluded from financial obligations where the e-waste from private households is concerned. A third group, consisting of eight countries, have altered Article 8(2) to the extent that producers can ignore the requirement to take individually responsibility for newly generated e-waste. In this same group, several of the listed countries decided that the financial costs for newly generated e-waste must be funded by the market share of producers, similar to the historical WEEE financing mechanism (Sander *et al.*, 2007:V).

- ***The Pay-As-You-Go (PAYG) principle***

A Pay-As-You-Go (PAYG) financial model refers to an instrument that assigns costs for the management of e-waste to the producers in relation to their market share when those costs arise. When producers are charged a flat fee for placing products on the market, it is included in the definition. This flat fee is derived from estimates of the sales of products and the expected return of WEEE in a given period, normally annually. It also applies to systems where the costs for collection and recycling are determined on calculations based on the market share (Sander *et al.*, 2007:45).

The Sander *et al.* (2007:184) report indicated that the “Return-share,” which is the share of returned WEEE from producers, can be calculated using two approaches:

- The first approach is a ‘random sampling,’ which is done at collection facilities, consolidation centres, recycling facilities and at the producer’s own mixed waste collection efforts. Each producer’s relative return-share is then determined by this sample.
- The second approach is ‘sorting by brand’ and here all collected and processed WEEE is sorted and counted/weighed in order to determine the producers’ “Return-share” of new and historic WEEE.

Sander *et al.* (2007:179) differentiated between financing main mechanisms, which can be used to manage e-waste, by assigning costs to producers. The author however agrees that the stated mechanisms are not a complete list of potential models that can be used for EPR programmes. This is an indication that financing models must be tailor-made for all countries. The descriptions of the financing mechanisms are listed below.

2.8.1 E-waste financing mechanism 1: Model A: Pay-As-You-Go (PAYG) model

Historical WEEE can be defined as EEE that was on the market before the introduction of a WEEE management system, and in some cases the producers of the EEE are no longer in business, leaving orphaned products behind. The PAYG model does not differentiate between historical and new e-waste and requirements. The market-share (according to weight of new EEE) within the different treatment category or product category determines the proportion of management costs payable by producers. An added advantage is that sorting or brand sampling is unnecessary since the financing model is a PAYG system, where the return-share does not need to be determined. With this model, producers accept the burden of financing orphan e-waste. Orphan products are products from producers that vacate the electronic or electrical market.

2.8.2 E-waste financing mechanism 2: Model B1: Return-Share model

The Return-Share model covers new e-waste and historical e-waste. The management costs are covered proportionally by producers after determination of the returned weight or number of their own-branded products. In this model, before costs can be allocated to each producer for historical or new e-waste, sorting of the waste stream or Brand-sampling is required. No differentiation between new WEEE and historical WEEE is needed as recycling fees are based on the Return-Share model.

2.8.3 E-waste financing mechanism 3: Model B2: Return-Share model

The B2 model is financed in the same way as model B1 with the exception that new WEEE costs are not calculated on weight only, but also on the intrinsic properties of returned e-waste.

2.8.4 E-waste financing mechanism 4: Model C1: PAYG for historical WEEE, Return-Share model for new WEEE

This model is a PAYG system for historical e-waste and a Return-Share system for new e-waste. This model is based on weight of products returned. This model demands that the e-waste stream distinguishes between historical and new e-waste, and the brand of

the new e-waste; this is done through sorting or sampling. This model may be seen as a more reasonable model by a wider group of stakeholders compared to the B1 and B2 models.

2.8.5 E-waste financing mechanism 5: Model C2: Return-Share model for new waste and a PAYG system for historical e-waste

Similar to C1, this is a Return-Share model for new e-waste and a PAYG model for historical e-waste. This model is not only based on weight of products returned but also on the phasing out of hazardous materials where the absence of these substances reduces the recycling fees.

The Association for Electric Home Appliances manages the recycling fee and fund in Japan (Yoshida & Yoshida, 2010:22). Aizawa, Yoshida and Sakai (2008:1407) reported that the majority of Japanese consumers dispose of e-waste properly. With the recycling fee paid upon disposal, 61% of consumers choose the most convenient disposal method, or the most environmentally sound method; the rest were more concerned about cost and either tried to avoid the recycling fee or keep it to a minimum. The same authors suggested that the recycling fee at disposal might in fact encourage illegal dumping of e-waste.

Recycling fees paid by consumers in Japan ranged between US\$23 and US\$46 at the time; this only covered the fee for recycling as US\$4 to US\$19 still needed to be paid to cover the costs to collect and transport the e-waste to collection sites. Retailers were required to collect and transport the EoL products from consumers. In April 2001, Japan started with a compulsory recycling system for business PCs, an initiative that was extended to residential PCs in the summer of 2003. It was called the “Law for Promotion of Effective Resource Utilisation.” At first local authorities managed the system, but after October 2003 manufacturers were grouped in the PC3R Promotion Centre. Manufacturers were required to collect and recycle/re-use PC-’s sold after this date. A “PC Recycling Mark” was placed on PC-’s that fell under the PC recycling programme and a recycling fee, which was not visible or non-refundable was included in the sale price; this ensured no additional charges were requested. Customers still had to pay a collection and

recycling fee that ranged between US\$29 and US\$40 if the products were purchased before October 2003 (Kahhat *et al.*, 2008:957).

In Taiwan, the recycling fee is managed by the RFMB, which is part of EPAT. Manufacturers and importers pay the recycling fee for new RRW products into a recycling fund. Eighty percent of the fees is distributed between eight (8) trust funds, which are structured according to a waste category. The remaining 20% of the income is allocated to a “special income fund;” private collectors and recyclers are then subsidised by this trust fund. This special income fund is used to administer EPAT’s 4-in-1 Recycling Programme, do auditing and certification, support outreach, conduct research and development on recycling processes, pay grants for municipal collection teams and recycling projects from the community. The subsidy tariffs for RRW items are determined based on the collecting cost, the recycling cost of the RRW type and the income generated by selling the valuable recovered materials or collected units to recyclers. The RFMB annually surveys collectors and registered recyclers on their costs to ensure accuracy of the data needed to calculate the recycling fees, the subsidies, and revenue received (U.S. EPA, 2012:17-18).

In Taiwan, similar to the system in Korea, amendments were made to the Waste Disposal Act. This ensured that importers and manufacturers had a financial responsibility by enforcing a recycling fee payment. The “Recycling Management Fund” collected the funds and distributed it to the recycling facilities. Televisions, washing machines, refrigerators, air conditioners, PCs and others were included in the e-waste stream. The fees for recycling were between US\$ 8 and US\$ 21 at the time (Kahhat *et al.*, 2008:958).

Kahhat *et al.* (2008:961) proposed a fee system for the American market called an e-Market for Returned Deposit system, where the consumer pays a deposit (D) on the purchase of a product. This deposit would then go to a fund-managing group. Upon recycling of the product the fund managing group pays the recycling company a fee (RT) equal to the deposit(D), less the overhead (O), per product for e-market fund management, thus $RT = D - O$. The recycling company thus receives a value of RT from which the cost to recycle (CF) is subtracted. The product has some positive value to the recycler and a value per item (V) should be paid to the customer. The value (V) is less than the positive value received after recycling. The value received (R) by the customer

was thus proposed to be $R=RT-CF+V$. The profit margin for the recycler lies in the difference between what the recycler receives for the product from the fund-managing group, less the cost to recycle and less the value paid to the customer.

Financial models differ around the world and as seen, there are different financial models for different countries. From the literature, it is clear that, even with one directive, financial models differ in EU states. From the perspective of the producers, different models exist. In some instances, the producers are collectively responsible for recycling of historical WEEE, and in other instances, producers are responsible for their current and historical WEEE recycling. From the customer's perspective, some of the models ensure that recycling fees are paid up front, some ensure that the producers are responsible for recycling fees, some collect fees at the disposal of WEEE items, and in some instances a deposit fee is proposed. Financial recycling contributions are needed to manage the WEEE recycling process effectively. No financial model exists for the South African household e-waste market and this research will address this issue. Financial stability is the key to progress and growth, and from personal experience with an e-waste related project the researcher found that sustainability using basic recycling techniques proved to be challenging. The need for investigating which financial model will suit South Africa best will be included in the study.

2.9 WEEE DESIGN AND TREATMENT SYSTEMS

Eco-design refers to the development of cleaner, more durable, and energy efficient products in which toxic materials are avoided. Firms have undertaken these activities as well as the development of products that can easily be disassembled for recycling (Gottberg *et al.*, 2006:40).

- ***Taiwan***

Since the realisation of the hazardous nature of WEEE, there has been new measures introduced in countries, especially in Asian and European countries, to reduce the negative effect. Mention was made of ROHS and DfE as measures to lessen the effects on the environment. WEEE recycling facilities must specialise on specific types of e-waste and have the capabilities to treat the e-waste stream effectively. Taiwan used techniques to recycle e-waste, which were established and used in developed countries. The majority

of subsidised e-waste recyclers use similar equipment and methods based on EPAT's regulations and requirements. As with many countries, the focus is on dismantling e-waste in Taiwan. Primarily their recycling methods include mechanised CRT separation, mechanised refrigerator shredding and separation, mechanised removal of refrigerator and air conditioner coolant, mechanised circuit board shredding, manual product disassembly, and manual phosphor powder removal. At the time gold, silver, and palladium could be recovered from motherboards and e-waste from two enterprises in Taiwan. EPAT regulates the environmental protection needed when refining takes place under Article 36 of the Waste Disposal Act. It does however not prescribe what type of equipment should be used during the refining process. EPAT prohibits the export of whole e-waste units but due to a limited refining capacity, some materials from e-waste are exported for further processing. Integrated circuit boards are categorised as mixed metal waste and considered as hazardous by Taiwan when exported; the boards are shredded and exported to other countries for further processing. The local Environmental Protection Bureau requires that all exports be recorded. Plastics, glass, copper, steel, and aluminium can be refined in Taiwan (U.S. EPA, 2012:20).

- ***Brazil***

Oliveira, Bernardes and Gerbase (2012:1606) differentiate between three types of e-waste recycling companies in Brazil. Some companies collect scrap, select the valuable products, and separate the valuable materials to sell recycling companies. Other recycling companies export printed circuit boards. A few international recycling companies mainly collect e-waste in the country for export to a foreign country, which has an industrial recycling plant. An example of this type of recycling company is UMICORE, which is a world-class precious metal refinery located in Belgium. Other examples are Cimelia, which has its recycling plant in Singapore, and Belmont, with facilities all over the world and which specialises in cell phone and circuit board recycling and refurbishing in São Paulo and Manaus (Oliveira, Bernardes & Gerbase, 2012:1606).

- ***Japan***

Recycled material in Japan is defined as only materials that are sold to the resources market. Recycled materials that have a negative value are not included in this definition. This has caused the recycling yield rate, which is the weight of recycled materials divided by the total weight of collected appliances, to increase to more than 70%. This has

resulted in eco-designs for easier disassembly and fewer types of plastic materials being used in products to increase the amount of recyclable plastic hazardous substances, such as CRT TVs, capacitors containing polychlorinated biphenyls, air conditioners containing mercury relay switches, and refrigerators containing ammonium, which must be managed by accredited recycling plants. This is made possible by manufacturers that provide recycling plants with treatment methods of the known contaminants in e-waste. Fluorocarbons are collected by manufacturers with withdrawal machines and some recycling plants employ computer-monitored withdrawal machines to obtain a higher withdrawal yield (Aizawa, Yoshida & Sakai, 2008:1404-1405).

Results from many research projects indicate that enormous amounts of e-waste are dumped in developing countries around the world. Recycling is done through manual processes in residential properties and backyards. The negative result is substantial pollution of water, air and soil in these countries. Some areas are affected with widespread pollution from these unsafe e-waste recycling processes, such areas/cities are Taizhou and Guiyu in China, New Delhi in India, Gauteng in South Africa, Accra in Ghana and Karachi in Pakistan (Kiddee, Naidu & Wong, 2013:1239).

- **China**

In China, the majority of owners of EoL domestic electric appliances do not regard televisions, washing machines, refrigerators, etc. as waste but rather as merchandise with value. Entrepreneurs would buy them from the owners, do minor repairs and resell them. What cannot be repaired will be stripped to collect the valuable materials for reselling. Recovering of the materials occurs under unsafe conditions for the environment and people's health. Qualified recycling plants must compete with such vendors who do not have cutting-edge recovery technologies as well as appropriate health and environmental protection measures. On top of this there are the accompanying costs to recycle. An example is given of a CRT that cost 120 Yuan to process and the reclaimed valuable material sold for 50 Yuan, less than half the processing price (He *et al.*, 2006:510).

From these examples, it is clear that Japan has changed the designs to ensure a better recycling yield. Previous literature indicated that EU directives have led to the introduction of measures such as ROHS to lessen the environmental impact. This section shows the

importance of using appropriate recycling facilities, which are designed specifically to extract valuable and hazardous components effectively. South Africa has e-waste recycling facilities but there is still a lack of facilities and local beneficiation (Arnoldi, 2018). This statement will be tested in the research study, as it is important to identify shortcomings, which need special attention in a future e-waste management system.

2.10 CONCLUSION

This chapter presented a global perspective on e-waste management. Key e-waste management parameters were discussed, specifically the mechanisms to co-ordinate and drive the e-waste management processes, e-waste legislation, collection arrangements of e-waste, financing models for recycling e-waste and WEEE design and treatment systems. In the chapter to follow, a South African perspective on e-waste management will be presented.

CHAPTER 3: A SOUTH AFRICAN PERSPECTIVE ON E-WASTE MANAGEMENT

3.1 INTRODUCTION

In the preceding chapter, a global perspective on e-waste management was examined. Some key measures to address WEEE recycling were discussed by considering mechanisms to co-ordinate and drive e-waste management processes, legislation, collection arrangements of e-waste, and financing models for recycling e-waste. In this chapter, these issues will be considered from a South African context. The lack of appropriate implementation in the specific areas will also be underlined, as this will be the focus areas of the research to be conducted. In the final section of the chapter, an existing theoretical model and conceptual model will be introduced where after a conceptual framework, which will guide the research process, will be discussed. The contribution from the researcher will give direction to the research and the chapter will end with research questions. These research questions are the basis of the investigation and will be addressed in the chapters to follow.

South Africa is a signatory to the Basel Convention (Advanced Tropical Environment, 2012:67), which prohibits trans-boundary shipment of hazardous waste, including e-waste, between countries. Signatories must strictly comply with this requirement (Ghosh *et al.*, 2016:696). The Bamako Convention came into force in 1998 and it is a treaty between African nations. The treaty specifies that the movement of any type of hazardous waste between African countries must be restricted (Iqbal *et al.*, 2015:311). South Africa is however still not a signatory to the Bamako convention (Ecolex, 2019), which implies that South Africa can import e-waste legally (Webster, 2002:93). E-waste from African countries can thus be imported and recycled locally, which could create jobs and ensure environmental protection.

As South African law does not require landfill managers or recyclers to keep accurate records of e-waste disposals, there are no reliable figures on e-waste volumes. It is however estimated that on average, a person generates 12 kg of e-waste per year and 85% to 90% of this waste ends up on landfills or will be incinerated (Fin24, 2013). In South Africa, the figure is around 6.2 kg of e-waste being generated per person (Mhlanga, 2018).

Statistics SA confirms this trend of non-recycling, by stating that 90% of general waste produced in South Africa end up in landfills. A low 5.2% of households participate in recycling (Stats SA, 2018). South Africa has approximately 58.56 million people (World population review, 2019), which implies that more than 300 000 tons of South African e-waste will not be recycled; this is in line with the calculations from the Department of Environmental Affairs who estimates the national generated e-waste to be approximately 360 000 tons (Mhlanga, 2018). The e-waste will not be recycled, but either illegally dumped, informally recycled, added to the general domestic waste stream, or stored by the owner. With an average of 6.2 kg e-waste being generated per South African per year, the recycling figure per capita for South Africans will be around 0.6 kg. Norway, Switzerland, and Sweden had figures of 13.41 kg, 11.44 kg and 12.2 kg collection per capita per year respectively in 2010, indicating the South African collection rate is very low compared to these countries (Yoshida & Yoshida, 2010:23). WEEE per capita is high and increasing in South Africa, even though the recycling rate is low compared to some first world countries.

Computers for refurbishing and selling to the lower income sector are high in demand in developing countries. The UNEP report (2009:45) estimates a growth of approximately 0.7 kilograms of e-waste from computers per person in South Africa per year. The storage of domestic e-waste is substantially high, while the same tendency can be observed from government departments and universities. It was predicted that “high” e-waste volumes would be entering the e-waste stream in 5 to 10 years (Advanced Tropical Environment, 2012:10).

Approximately 70% of South Africa’s e-waste is stored, while the Government has the most e-waste in storage; this is due to the difficulty of writing off technology assets from registers thus contributing to the high storage level (Finlay, 2005:7). The lack of collection and disposal processes, as well as a lack of awareness from the public of what to do with e-waste, are some of the main factors for the high levels of storage in the public domain. Other contributing factors are a belief that old technology has a hidden value and a fear of data theft on storage devices contributes to the storage of EoL equipment (Finlay, 2005:7).

Similar levels of low awareness on e-waste recycling were found in a Romanian study where respondents (43.48%) indicated there was a lack of information as to where non-functional items must be disposed. Despite knowing where current collection points are located, they often prefer other methods, such as returning items to the retailer, because they are not aware of what happens at the collection points (Colesca, Ciocoiu, & Popescu, 2014:363-364).

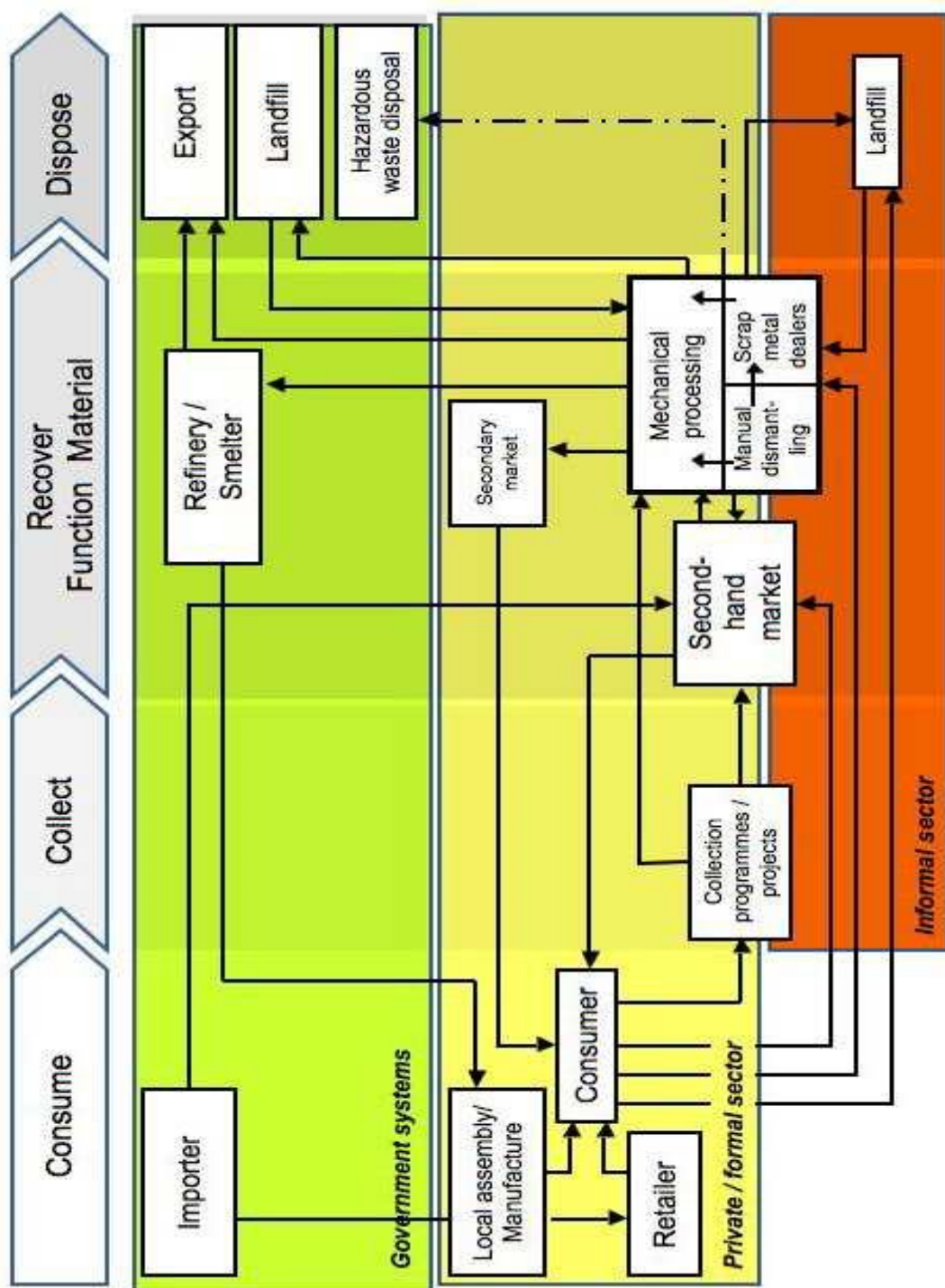
Panambunan-Ferse and Breiter (2013:226) use a figure of 0.1 kg per cell phone to calculate the total weight of e-waste per year from cell phones. According to the World Consumer Income and Expenditure Patterns (2013), South Africa has 64 million cell phones in use, and if the same calculation method is employed (assuming a 2 year life span of a cell phone) there is an average cell phone e-waste figure of 3500 ton per year, excluding obsolete cell phones, since they came on the market in 1995.

In the previous chapter, the current E-waste management practices, or lack thereof, in certain countries were shown. The measures to address WEEE recycling were discussed under the main topics of mechanisms in order to co-ordinate and drive the management processes, legislation, collection arrangements of e-waste, and financing models for recycling e-waste. These topics and the detail headings will be used in an analysis of the current South African situation. The lack of appropriate measures in specific areas will be highlighted, as this will be the focus areas of the research to be conducted.

3.2 MATERIAL FLOW IN SOUTH AFRICA

Material flow analysis is a widely accepted tool in the discipline of industrial-ecology. Material flow analysis measures the input-output materials and investigates the paths and fluctuation of each material flow within the complete system (Islam & Huda, 2019:344). In this study, the focus is however not on material flow analysis but addressing shortcomings to ensure urban household e-waste is disposed efficiently; in order to do this, an overall picture is needed of the flow of the e-waste from the EEE stage to the disposal stage. The roles of Government, the Private sector and the informal sector will be discussed in the following section. The flow of the e-waste from collection to disposal will also be addressed.

Figure 3.1: E-Waste flow diagram for South Africa



Source: Finlay and Liechti, 2008:46

Figure 3.1 gives a graphical representation of the e-waste flow in South Africa. This indicates how government structures, the private sector and the informal sector integrate in the flow of e-waste. The mass flow of e-waste can be categorised in the following three zones:

- **Zone 1: The Government systems** are indicated in the green top zone. They monitor and control some sections of the e-waste system. Specific permits are required and monitoring and regulation is done on importing, refineries and smelters. In the case of exporting and municipal landfills, these areas are mostly managed by local government. Specific permits and controls are required for hazardous waste facilities. It was predicted that the management of all municipal wastes, e-waste included, would be one of the biggest challenges for South Africa in decades to come. Due to economic development and fast urbanisation, a massive amount of waste will be generated by South Africans in the future (Panambunan-Ferse & Breiter, 2013:225). An e-waste management system is thus needed to address the increase in generated e-waste and the need for the research study is evident.
- **Zone 2: The Private/Formal sector**, as indicated in the yellow middle zone, is mainly self-organised. Standard business practices regulate this zone. Consumers buy products from retailers, which acquired the EEE from producers. At the EoL stage, the e-waste items could end up in the recycling stream where private businesses recycle for profit. The zone is made up of consumers, retailers, local manufacturers, recycling and second-hand businesses as well as formal collection initiatives from the private sector. The current study will investigate proposals from the private sector, which will ensure cohesion for effective e-waste management.
- **Zone 3:** The Informal sector is represented by the orange (bottom) zone. This sector is actively involved in e-waste collection from landfills and other areas, manual dismantling, the second-hand market and engages with scrap dealers and recyclers. The main purpose of the informal recycler is to make a living, which in turn often leads to serious environmental pollution due to incineration, landfilling, acid extraction and dumping. This has been proven in several studies. According to Wang, Guo and Wang (2016:857), informal recycling is dominating the Chinese e-waste market to the point where formal e-waste recyclers often find themselves in a situation where they have no e-waste to recycle. Islam *et al.* (2016:738) found a similar situation in Bangladesh, where consumers also sell e-waste to the informal sector with the result of hazardous recycling and adverse environmental impacts.

The Advanced Tropical Environment (2012:33) uses the same graphical presentation given by Finlay and Liechti (2008:46), indicating that the situation is unchanged. The role of informal waste collectors, as well as the rest of the different stakeholders, in e-waste management needs to be investigated to ensure effective collection, recycling and disposal in the future.

Figure 3.1 also depicts the formal WEEE value chain in South Africa. E-waste flow from Consumption, to Collection, to Recovery, and finally to Disposal is the standard material flow in Switzerland and other countries (Duygan & Meylan, 2015:99; Khatriwal, Kraeuchi & Widmer, 2009:157).

Stage 1: Collection

In the South African context, e-waste is typically collected from electronic repair shops, although many recyclers buy e-waste from informal collectors; this however is on a small scale (Lawhon, 2013:705). One of the biggest e-waste collectors, Desco, collects e-waste from bins that are placed at Makro, Hi-Fi Corporation and Incredible Connection. The company also receives e-waste at their recycling plant (Mhlana, 2018). Access to e-waste is limited in South Africa due to e-waste being stored in homes, offices and storerooms. Unlocking the e-waste can grow the recycling economy, increase technology investment and create new technologies (Naidoo, 2017).

Stage 2: Recover Functional material

Recovery of materials starts with a pre-processing process where copper, silver, and steel, etc. will be extracted. Other portions of the e-waste will be extracted using processes involving smelters (Duygan & Meylan, 2015:102). Recycling processes between South African recyclers are not uniform, as they can be mechanised shredding or manual dismantling. Value is added with manual dismantling when fractions are separated. This allows the sale of fractions to different markets. Universal Recycling Company (one of the biggest South African ferrous and non-ferrous metals recyclers) uses a combination of shredding, conveyor belts, rotary magnets, water separation, granulation, extractors, and shears and balers (Universal Recycling Company, 2019).

Desco Recycling, one of the larger South African e-waste recyclers, relies more on dismantling and hand sorting; they also remove re-usable parts and resell them to the second-hand market. Desco Recycling also make use of machinery that was developed to process PC boards. These PC board fractions are then transported to a refinery for smelting and extraction of valuable material; dismantled fractions are sold locally and internationally (Desco, 2019: Finlay & Liechti, 2008:32).

Roughly 80% of plastic and 90% of printed circuit boards recovered from e-waste in South Africa are exported for reprocessing. This is due to South Africa not having the technology to handle such large scale processing. E-waste is exported illegally to countries such as India or China (Naidoo, 2017).

Stage 3: Disposal

The National Environmental Management Act (Act 107 of 1998) provides the framework for comprehensive environmental management. The National Environmental Management Act refers to proper waste disposal, which includes e-waste. Informal e-waste scavengers buy obsolete electronic equipment at auctions and strip the items, which has immediate value, e.g. copper, aluminium, steel, etc. The rest (and biggest) of the waste is dumped at illegal e-waste dumping sites, or in the municipal landfill. Toxins such as cadmium, arsenic, lead, beryllium, mercury, and other heavy metals are then released into the environment (New Earth Waste Solutions, 2019).

Conclusion and implications for this study

From the literature reviewed, it is evident there is currently no dedicated Government intervention and control in the recycling of e-waste in South Africa. Collection and recycling of e-waste is done on a small scale, as the overwhelming e-waste is not recycled, but either stored or dumped. There are recyclers who do recycling in an environmental friendly way, but final extractions cannot be done in South Africa due to limitations. The systems in place allows informal recyclers to get hold of redundant equipment, to do extraction of only the valuable parts, and to dump the rest illegally. The National Environmental Management Act act touches on disposal principles, but this does not deter informal recyclers from engaging in illegal practices. The materials flow diagram is an indication that an informal recycling system for e-waste exists but that this system is inadequate to dispose e-waste effectively as 300 000 tons of South African e-waste will

not be recycled per year (Mhlanga, 2018). The limited influence of legislation and government initiatives, the poor collection infrastructure, and the limited recovery capabilities of rare earth materials calls for the development of a framework to address the issue.

The study should thus investigate ways that will ensure effective collection, environmentally friendly recycling, and correct disposal methods.

3.3 CURRENT MECHANISMS TO CO-ORDINATE AND DRIVE THE E-WASTE MANAGEMENT PROCESSES IN SOUTH AFRICA

3.3.1 Extended Producer Responsibility

EPR is as an “environmental policy approach in which a producer’s responsibility for a product is extended to the post-consumer stage of a product’s life cycle” (OECD, 2019a). EPR has not yet been implemented in South Africa, as is the practice in Europe and producers of EEE products do not have any role in e-waste recycling. Some companies only boost their corporate image by taking certain responsibilities (Advanced Tropical Environment, 2012:31).

The National Environmental Management Act, No. 59 of 2008 entered into force on 10 March 2009, and required the Minister of Environmental Affairs to draft a National Waste Management Strategy (Waste Policy, 2008:20). A National Waste Management Strategy was published in May 2012 and e-waste was specifically mentioned. The implementation of EPR on e-waste was a priority and had to be investigated for implementation after the point of sale (Advanced Tropical Environment, 2012:40).

To date, EPR made progress in the packaging industry and was investigated in the tyre industry in South Africa (Hartley, Caetano, & Daniels, 2016:2; Packaging SA, 2018). However, there is still a lack of certainty around a legislative framework covering EPR for the South African e-waste industry (South African E-waste Alliance, 2019).

Conclusion and implications for this study: EPR as a strategy, and the roles and responsibilities of producers in the South African e-waste recycling scenario, need to be investigated to determine if that would be the best route or should Product Stewardship

be the instrument to handle the EoL stage. Should EPR be deemed the most appropriate tool to contribute most effectively to high WEEE recycling figures in South Africa, the study will highlight it, and the research will contribute by giving suggestions from data received in the form of the framework which will be designed and discussed.

3.3.2 Stakeholder responsibility

In Table 3.1, the major stakeholders included into research studies involving e-waste are identified as shown.

Table 3.1: Stakeholders in the South African e-waste environment

Stakeholders	Source
Producers- Manufacturers, Importers	Khetriwal, Kraeuchi and Widmer (2009:153)
Retailers	
Consumers	
Collectors	
Recyclers	Imran <i>et al.</i> (2017:137)
Refurbishers	
Government structures	
E-waste associations	Lawhon (2012:958)
NGO's and environmentalist	

Consumers are the starting point to ensure the success of an e-waste recycling system, as the disposal process kicks off with them. According to the World Consumer Income and Expenditure Patterns (2013), South Africa is a low-income country with a yearly disposable income per capita of 6323 USD (+- R93 000 in 2019), has an unemployment rate of 24.4% and 50% of the population lives below the poverty line. It further indicates that the consumer expenditure per capita on household goods and services (including electrical and electronic equipment, fridges, freezers, etc.) is 27 USD/year, which is very low compared to other countries. It is an indication that household goods are not replaced regularly and are used until they cannot be repaired. South Africans are among the highest cellular phone users in the world, with 1.32 cellular phones per capita. With South Africa being amongst the poorer countries, one can safely assume that consumers have some attachment to EEE and even WEEE, and that consumers regard WEEE as items with some form of monetary value. During the research among consumers, this assumption will be tested. A recycling process must involve different role-players in the e-waste industry, as indicated in Table 3.1. It is imperative to include the majority, if not

all, of the mentioned stakeholders in the study. Each group can contribute to the study and has a vital role to play in any efficient system.

Conclusion and implications for this study: Just as the roles and responsibilities are defined in some countries, the roles and responsibilities of all stakeholders in South Africa must be explored in the current study to ensure a cohesive environment for the effective management of e-waste. To acquire data from the consumers of e-waste to determine which drivers will positively affect recycling habits and behaviours, it is envisaged that a survey will have to be done among urban South African consumers. To get insight and knowledge from the rest of the stakeholders it is envisaged that interviews will be the best instrument to acquire information which can be used in the development of a framework to address the problem.

3.3.3 Systems coverage and ensuring compliance

In the European member states, private household WEEE is categorised into two compliance categories. The first compliance scheme is categorised as a “competing collective system” if more than one compliance scheme is handling the same category WEEE in competition; the second compliance scheme is categorised as a “single national compliance system” if there is no competition. The purpose of a compliance scheme is to cover e-waste recycling from collection to final disposal (Sander *et al.*, 2007:97). From the previous section, it is clear that in South Africa there is no compliance scheme, legislation around EPR is unclear, and no compliance is mandated. A compliance scheme of some sort is needed to give South African stakeholders direction. Without a compliance system, e-waste will just pile up in homes, be disposed in landfills, and humans and the environment will be negatively affected.

Conclusion and implications for this study: In South Africa no systems coverage is in place where e-waste is concerned (South African E-waste Alliance, 2019). Compliance of effective recycling can thus not be ensured. A compliance system fit for the South African scenario is needed and needs to be researched and designed. The purpose of the research study is to propose a system that will enable all systems to be covered and to propose a system that will ensure the compliance of all stakeholders.

3.3.4 Registry for E-waste

A registry for e-waste is a method of keeping track of what is placed on the market, from where the products originate, and can keep track of e-waste volumes. According to Campen and Enders (2016:2), importers in Nigeria must be part of a registry to report imported volumes of new and used EEE. In the South African context, the household appliances are mainly imported with a few products being manufactured locally. By keeping a registry, the numbers and weights of EEE being placed on the market will be traceable. Producers can be involved with a recycling system based on their EEE production into the market, recycling figures can be calculated, and recycling targets can be set. In the present South African context, the Government has a registration process called the “Manual registration form for registering with the South African Waste Information System (SAWIS).” The registration process is a requirement of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), and the purpose is to report waste information to the National Department of Environmental Affairs (Department of Environmental Affairs, 2012). The SAWIS system however only requires persons involved with waste activities to register, which excludes importers, manufacturers, and retailers.

The Advanced Tropical Environment (2012:104) suggests that producers should set up and fund a single registry. With a single registry, import figures, sales figures, collection figures, disposal figures/weights, recycling figures/weights, etc., can be incorporated into a national system. The SAWIS system will thus be inadequate to address the needs of a proper e-waste register.

Conclusion and implications for this study: The need for a registry must be investigated as it could contribute to effectively managing an e-waste system. Furthermore, there is a need to determine who should administer such a registry if research indicates a need. The best suited administering body will thus be determined from the study.

3.4 E-WASTE LEGISLATION IN SOUTH AFRICA

In 2007, a report was released by Dittke, an Attorney from Cape Town, to review the e-waste legislation in South Africa. This report, which was updated in 2009, was commissioned and prepared for the Electronic Waste Association of South Africa (eWASA), supported by the State Secretariat for Economic Affairs (SECO), the Swiss e-Waste Programme, and the Swiss Federal Laboratories for Materials Testing and Research (Empa). The report highlighted that South Africa does not have any dedicated e-waste laws, as is the case in many other countries. To get clarity on e-waste issues, a variety of health and safety as well as environmental laws were analysed and included in national, provincial and local legislation; this was a strenuous and inadequate situation and made it difficult to clarify matters (Dittke, 2009:6). It concluded that South African legislation on hazardous waste, particularly e-waste, is unclear. The differences in strictness and enforcement of waste removal, due to it being mainly regulated on a local level, were criticized. Thus, previous legislation has not identified or mentioned e-waste as being hazardous and that there is a general lack of awareness regarding the nature and danger of e-waste from the public and, to an extent, the authorities (Dittke, 2009:48). South African laws are applicable to e-waste as it includes areas such as water, the environment, air, hazardous substances, waste, as well as health and safety matters. If the laws are closely examined, answers could be extracted but it is confusing as the laws were implemented with a different perspective, not from an e-waste point of view. In South Africa, the enforcement of the environmental laws are not uniform when dealing with hazardous waste in general, or e-waste, as the enforcement is done by different government departments. The provincial and national government share constitutional power on pollution with the result that there is often a lack of cooperation and conflict between the two levels (UNEP, 2009:59-60).

In the National Waste Management Strategy (Waste Policy, 2008:44) it was stated that mandatory industry waste management plans must be prepared for the lighting industry for mercury containing lamps, e.g. compact fluorescent lamps (CFL's). It is suggested that integrated industry waste management plans should be developed for different forms of e-waste and batteries, and other waste streams that are best managed through an industry waste management plan.

Towards the end of 2013, a news release on the eWasa website stated, “As you may be aware e-waste has not been deemed a priority in terms of the Waste Act, therefore it was not mandatory for the sector to submit industry waste management plans. Notwithstanding the above, eWASA and The Information Technology Association of South Africa Producer Environmental Group both submitted voluntary IndWMP to the DEA in 2010. For the past 15 months the two parties aligned their IndWMP's and agreed on a high level e-waste framework model.” The website also stated the two organisations “held discussions with Mark Gordon (DEA) and were advised that the DEA would prefer the e-waste sector to establish a Statutory Council along similar lines to the current Green Building Council, as opposed to submitting a revised joint IndWMP. It is proposed the council would be known as the E-waste Council of South Africa (EWACSA). We are led to believe that once established the DEA would amend current legislation to recognise this Council as a Statutory Body, mandated to manage the e-waste sector.”

Despite these discussed attempts and impetus, the past decade has seen no e-waste legislation in South Africa. The recent report by Forti, Baldé and Kuehr (2018:48) confirmed that South Africa still did not implement any dedicated national e-waste legislation. South Africa is just beginning to institute EPR via legislative prerequisites for producers to pay for the responsible take-back and treatment of post-consumer WEEE.

Conclusion and implications for this study: Legislation of e-waste per se has not yet been introduced for South Africa. The importance, and high yearly recycling numbers, of dedicated e-waste legislation in mainly developed countries have been discussed in 2.5.1. Dedicated e-waste legislation thus plays a very important role. There is also no guarantee that the DEA will amend current legislation to recognise this council as a statutory body, which is mandated to manage the e-waste sector. The appropriateness of introducing legislation, and which stakeholders must be included in the discussions, needs be determined for the South African context.

3.5 COLLECTION ARRANGEMENTS OF E-WASTE IN SOUTH AFRICA

3.5.1 Composition of South African e-waste

E-waste recycling systems are not uniform and recyclers in South Africa receive different kinds of e-waste, which is classified into eight classes: 1). Small household appliances; 2). Large household appliances; 3). Office, information and communication technology (ICT) equipment; 4). Consumer electronics and entertainment equipment; 5). Lighting equipment; 6). Electrical and electronic tools; 7). Security and healthcare equipment; 8). Mixed waste electrical and electronic equipment. Examples of each type is shown in Table 3.2. (Section a).

In an attempt to overcome the lack of an integrated framework to measure the flow of e-waste in South Africa, Lydall, Nyanjowa, and James (2017) conducted a survey with 23 prominent recycling companies that formally dealt with e-waste across South Africa. They found that 17.733 tonnes of e-waste was handled by these recycling companies on average per annum. Most of the e-waste was in the form of ICT and consumer electronics (79%), followed by large and small household appliances (15%), lamps (14%) and other items (2%), as displayed in Table 3.2.b. The National and Provincial Government (45%) was the sectoral source producing the largest portion of E-waste, followed by households (35%) and the business sector (20%), as displayed in the chart in Table 3.2.a.

After dismantling and sorting, recyclers pass the fractions on to other recyclers; a small dismantling recycler might sell PC boards and scrap metal to different recyclers. Recyclers receive a range of e-waste such as mobile phones, PCs, scanners, fax machines, photocopiers, medical and radio equipment, monitors (including LCD panels), televisions, fridges, irons, and telecommunications equipment. Un-recyclable fractions, such as plastics, batteries, and CRTs, also form part of the e-waste collection. Some recyclers responsibly dispose of CRTs but some crush or shred e-waste without first removing CRTs. Stockpiling of hazardous fractions, such as batteries, occurs and the market for e-waste plastics is almost non-existent (Finlay & Liechti, 2008:33).

The current regulatory framework in South Africa does not allow for the quantification of the amount of e-waste (referring to the hazardous components) handled by the informal

sector. The informal sector does not have to report to anybody, apart from selling profitable extracted materials to recyclers (Advanced Tropical Environment, 2012: 74, 75). Informal recycling is difficult to regulate and informal collectors, in general, do not understand the dangerous and harmful effect e-waste has on humans and the environment (Orlins & Guan, 2016:75-77).

Conclusion and implications for this study: Recyclers in South Africa receive a wide range of electronic equipment, some of which can be re-distributed to other recyclers and some that cannot due to limitations in infrastructure and possibly a lack of knowledge. The need, if any, for the separation of different e-waste streams, as well as the separation location/facility, must be investigated. Government and the business sector work on a business to business model. This implies that EEE which was acquired can be channelled back to the originator when it becomes e-waste or alternatively recyclers can acquire the e-waste through tendering or bidding processes. E-waste disposal channels of government and the business sector is relatively easy to implement and will not be the focus of this research. Household consumers work on a business to consumer model where there are limited channels to dispose of e-waste. A government or business employee receives a laptop/personal computer and perhaps a small printer to perform his/her duties. The same person have household items (Table 3.2.a) such as a fridge, stove, television, dishwasher, etc. The volume of household e-waste items are thus overwhelming if compared to office equipment, yet only 35% of e-waste received by the recycling sector is from households. The need for research on collection and recycling of household e-waste in the South African scenario is thus evident and will be the focus of this research.

Table 3.2: E-waste in South Africa

a) Categorisation of e-waste in South Africa																			
E-waste Category	Examples																		
Small household appliances	Vacuum cleaners, coffee machines, toasters, irons																		
Large household appliances	Washing machines, refrigerators, dryers, air conditioners																		
Office, information and communication technology (ICT) equipment	PCs, laptops, mobile phones, fax machines, printers and photocopiers																		
Consumer electronics and entertainment equipment	Televisions, VCR/DVD/CD players, hi-Fi sets, radios, train sets, coin slot machines, parking ticket equipment																		
Lighting equipment	Fluorescent tubes and lamps, sodium lamps																		
Electrical and electronic tools	Drills, electric saws, sewing machines, lawn mowers, large stationary tools, machines																		
Security and healthcare equipment	Surveillance and control equipment, medical instruments and equipment																		
Mixed waste electrical and electronic equipment	Various e-waste																		
b) Volumes of E-waste handled	c) Sectoral sources of E-waste																		
<table border="1"> <caption>Volume of E-waste handled by category</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>ICT & Consumer electronics</td> <td>79</td> </tr> <tr> <td>Large & small household appliances</td> <td>15</td> </tr> <tr> <td>Lamps</td> <td>4</td> </tr> <tr> <td>Other</td> <td>2</td> </tr> </tbody> </table>	Category	Percentage	ICT & Consumer electronics	79	Large & small household appliances	15	Lamps	4	Other	2	<table border="1"> <caption>Sectoral sources of E-waste</caption> <thead> <tr> <th>Sector</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>National & Provincial government</td> <td>45</td> </tr> <tr> <td>Business sector</td> <td>35</td> </tr> <tr> <td>Households</td> <td>20</td> </tr> </tbody> </table>	Sector	Percentage	National & Provincial government	45	Business sector	35	Households	20
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Other	2																		
Sector	Percentage																		
National & Provincial government	45																		
Business sector	35																		
Households	20																		

Source: Lydall, Nyanjowa & James, 2017

3.5.2 E-waste collection points

South Africa has approximately 58.56 million people (World Population Review, 2019), yet despite this large population, there seems to be limited e-waste collection points in the country; there is also no exact figures available. Below are key drop-off points available in South Africa where e-waste can be disposed responsibly (Advanced Tropical Environment, 2012:65):

- Some Fujitsu, Makro stores and Nokia have service outlets such as Desco/Samsung recycling bins at entrances.
- Municipal e-waste drop off sites concentrated in Gauteng and Western Cape.
- Pikitup Garden refuse sites in Gauteng with some allowing e-waste.
- Retailer collaboration buy-back promotions at Incredible Connection and Hi-Fi Corporation, as well as e-waste recycler collection points.
- E-waste drop-off points for consumer at retailers (i.e. Pick and Pay, Builders Warehouse and Woolworths). These drop-off points are often removed without notification, and catered only for small e-waste items, such as batteries, lights, and printer cartridges.
- E-waste Collection points at academic institutions (i.e. UNISA, University of Stellenbosch and Cape Town).
- Dell provides a free consumer-recycling programme for EoL Dell equipment, which is replaced by new purchases.
- Buy-back centres that will purchase e-waste, scavengers that collect e-waste on landfills, and scrap metal dealers who will buy e-waste (Advanced Tropical Environment, 2012:30).

The above e-waste collection points are however not ideal. Some bins are not practical for breakable e-waste items, and informal waste collectors are often concentrated at these sites, posing a security risk. Retailer collaboration buy-back at Incredible Connection typically only occurs one week per year. E-waste drop-off points, at retailers, are often removed without notification, and are for small e-waste items only, such as batteries, lights and printer cartridges. Municipal drop off points are not regulated when e-waste is disposed by consumers.

Conclusion and implications for this study: It seems there are some promising initiatives in South Africa to collect e-waste, but they are not ideal. Research in South Africa is therefore necessary to determine the best collection methods, the most effective collection facility locations, collection facility arrangements including sorting, and possible transport arrangements for the collection of WEEE. The collection arrangement for household e-waste will be investigated during this research, where the contributions from e-waste specialists and the consumers will be captured, analysed, and concluded with proposals.

3.6 FINANCING MODELS FOR RECYCLING E-WASTE IN SOUTH AFRICA

In section 2.8 of Chapter 2, the financing models applied around the globe have been discussed. The purpose of a financing model is to ensure that e-waste recycling is done responsibly. Recycling starts at the collection and transportation of e-waste to recycling points. Recycling of all fractions should be done, including those that have negative value, meaning it will cost money to dispose of the fractions. Seager *et al.* (2012:6) proposed that producers should take responsibility to fund the end-of-life management stage of their products. This would include collection and treatment of the e-waste where they as the producers decide on the most suitable financing mechanism to deal with e-waste. There has to be a safety net to ensure that negative value fractions of WEEE are also collected and treated.

Without a financing model to fund negative value items, collectors and recyclers will not be interested in e-waste containing these items. It could result in valuable items being removed and negative fractions being dumped. Currently there is no dedicated legislation regulating e-waste in South Africa (Ledwaba & Sosibo, 2017:12; South African E-Waste Alliance, 2019), resulting in no financial model to assist with e-waste recycling.

Recyclers typically advise that collection at a site is only financially viable if the collected e-waste is above 400 Kg per visit. While some larger metros may introduce some recycling initiatives and practices on local government level, almost no e-waste recycling is done at small South African municipalities due to human resource and financial constraints (Finlay & Liechti, 2008:2829).

Conclusion and implications for this study: There are advantages and disadvantages to the different financial models used by countries actively involved in WEEE. South Africa is in need of a WEEE framework and an efficient financial model will be proposed from the research. The research will give direction as to how the e-waste management system will be financed and who will be administering the funds.

3.7 WEEE DESIGN AND TREATMENT SYSTEMS

Finlay and Liechti (2008:55) highlighted a few problematic practices associated with the environmental protection in South Africa:

- From 10 recyclers and refurbishers, only one was ISO 14001 compliant and one was in the process of being certified.
- Mechanical shredding of monitors releases ozone-depleting and greenhouse gases. The same applies to white goods, such as freezers and fridges.
- Hazardous fraction stockpiling occurred.
- Recyclers pass hazardous fractions to other recyclers without knowing if, or how, the recipient will dispose of it.
- Landfilling of potentially harmful plastics for which no market can be found.
- Batteries are removed from IT e-waste, but there is uncertainty as to what happens to them before recycling.
- Some properties are not properly enclosed, which allows contaminated water to run-off.
- E-waste exposure to the elements of nature.
- Water run-offs are not treated by recyclers and fractions are landfilled without being tested beforehand for toxicity.
- Although recyclers reported that no chemicals containing hazardous substances were used in e-waste recycling processes, some on-site incineration practices were reported.

A potential threat in the South African market is the setting up of backyard electrochemical processes, similar to what is happening in India and China. Precious metals can easily be extracted using the electrochemical processes and if the process is unregulated, a health hazard could occur if the dangerous toxic chemicals are casually disposed of (Finlay & Liechti, 2008:32).

Conclusion and implications for this study: It is evident that environmental protection from e-waste in South Africa needs serious attention. To ensure effectiveness in South Africa, minimum standards and procedures need to be enforced and the appropriate enforcing body needs be determined.

3.8 FACTORS RESTRICTING E-WASTE MANAGEMENT EFFECTIVENESS IN A SOUTH AFRICAN CONTEXT

Nnorom and Osibanjo (2008:855) identified restricting factors, which contribute to an ineffective e-waste management system as well as an ineffective informal WEEE processing sector. South Africa is a developing country and these factors will have a direct influence on the proposed South African framework. The factors are:

- Consumers see e-waste as a resource from which income can be generated.
- Consumers are unwilling to pay for the disposal of their e-waste or to hand over EoL goods.
- Consumers are unwilling to pay for disposal and waste recycling services, especially if money can be made from the sale of old and broken appliances.
- Consumers are emotionally attached to old EEE and to the perceived value of such EoL equipment.
- A high level of un-coordinated e-waste imported under the pretence of second-hand devices.
- There is an absence of e-waste legislation as well as an ineffective and poor implementation of regulations on e-waste management and on trans-boundary movement of waste.
- The potential hazards of WEEE are not known by consumers, collectors and recyclers.
- There is a lack of finances, which is needed for the improvement in e-waste recycling practices.
- Sustainable development principles cannot be followed due to the non-existence of infrastructure for the effective management and recycling of e-waste.
- Either there are no take-back programmes for EoL equipment, or it is ineffective.
- In the developing countries, multi-national ICT companies show little interest in the management of e-waste.

Conclusion and implications for this study: It is evident that many of the above factors are very real in the South African environment and contribute to the ineffective recycling of e-waste. As a developing country where consumers are emotionally and financially attached to e-waste, solutions are needed to persuade them to dispose e-waste. Best mechanisms to receive household e-waste will be investigated in the study and incorporated in the findings.

3.9 CONCLUDING REMARKS ON CURRENT MECHANISMS TO CO-ORDINATE AND DRIVE THE E-WASTE MANAGEMENT PROCESSES IN SOUTH AFRICA

The guidance notes of Volume II of the UNEP (2007b:33-37) and the key parameters, as identified by Widmer *et al.* (2005:447-448), were used as an integrative framework, encapsulating all the elements from the two documents. The elements of the framework were then used as the basis to analyse the South African situation. In most developing countries in Africa, there are limited measures to address the problem. Some African countries are unfortunately a dumping site for e-waste from developed countries.

A system that works in one country will not necessarily work in another, or in South Africa. South Africa has its own unique cultures and problems and a framework specifically for the South African environment is needed to address and solve the e-waste scenario. From the preceding sections, it thus is evident there are South African factors that contribute to the ineffective recycling of e-waste. There is currently no EPR programme in South Africa, no ensuring of compliance, the e-waste sector register is incomplete, legislation for e-waste is poor, collection arrangements are limited, no financing model exists, and the treatment of e-waste from some recyclers is appalling in some cases.

3.9.1 Theoretical frameworks and conceptual models

Grant and Osanloo (2014:12-13) state that the theoretical framework in a research study is the metaphorical and literal basis from which all knowledge is constructed and it aids in the structure and support for the justification of the study. The problem statement, the purpose, the significance, and the research questions are directed by the theoretical framework, and thus the framework is an anchor for the literature review, as well as the methods and data analysis. A research study with a theoretical framework gives the

structure and vision for the research and allows for the organised flow from one chapter to the next.

The use of a theoretical framework for the current research study is crucial to formulate the research questions, and to steer the process to collect and analyse applicable data, which will answer the research questions.

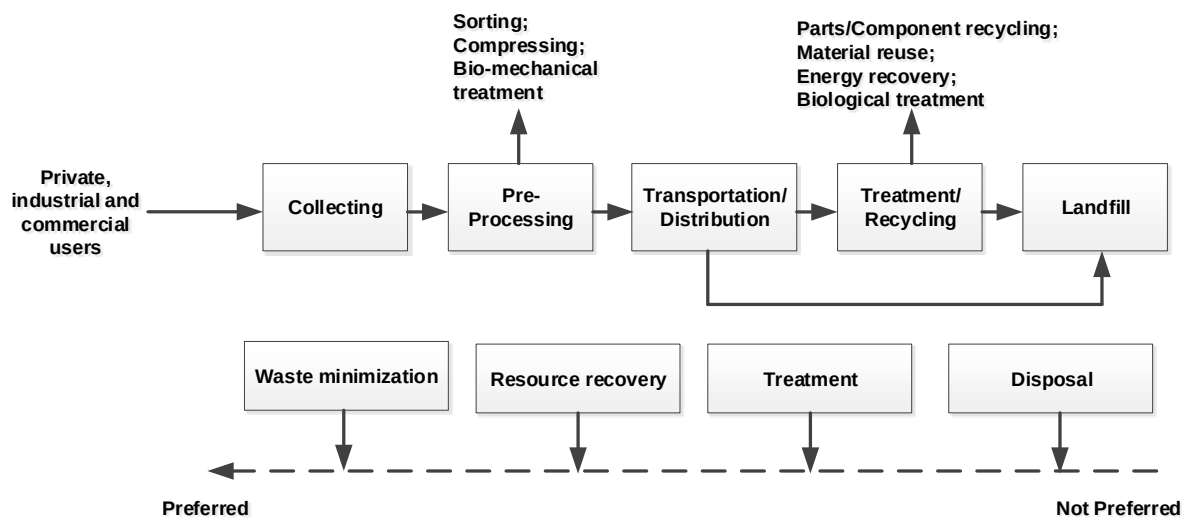
A conceptual model, conversely, is the researchers' understanding of how the research problem will be best investigated, the direction the research will take, and the relationship between the different study variables. Due to their research endeavours, doctoral candidates are encouraged to develop their own blueprint for a new theory, starting with a conceptual model (Grant & Osanloo, 2014:16-17). A conceptual model is regarded as a system of assumptions, concepts, and beliefs, which guide and support the research plan by focusing on the key factors, variables and constructs, and by assuming relationships between them (Miles & Huberman, 1994:440).

3.9.2 Theoretical framework of a sustainable waste management system

Figure 3.2 displays the theoretical framework applied by Yu *et al.* (2015:31) to depict a sustainable waste management system. This framework indicates that waste management starts with waste collection, and goes through treatment/recycling until it is finally disposed. The theoretical framework was developed in accordance with work done by Solvang *et al.* (2006:353), and Solvang and Hakam (2010:75).

The framework consists of an upper and lower part. The upper section shows the waste flow starting at end-users, then moving to collection, pre-processing, transportation/distribution, treatment/recycling, and then to final disposal. In this waste management hierarchy, landfill is the final destination, and the most hazardous. If landfills are not treating leachate, it will lead to surface and underground water pollution, which is normally irreversible.

Figure 3.2: Theoretical framework of sustainable waste management system



Source: Yu et al., 2015:31

The lower section depicts the preferred methods of waste management sustainability. Waste minimisation is the most preferred method, while resource re-use (including remanufacturing and recycling) is the second best way to waste management sustainability. Resource recovery of solid waste ranks third, while the least preferred sustainable waste management method is disposal. Disposal has a severely negative environmental impact and is a waste of a natural resource, which may not be renewable.

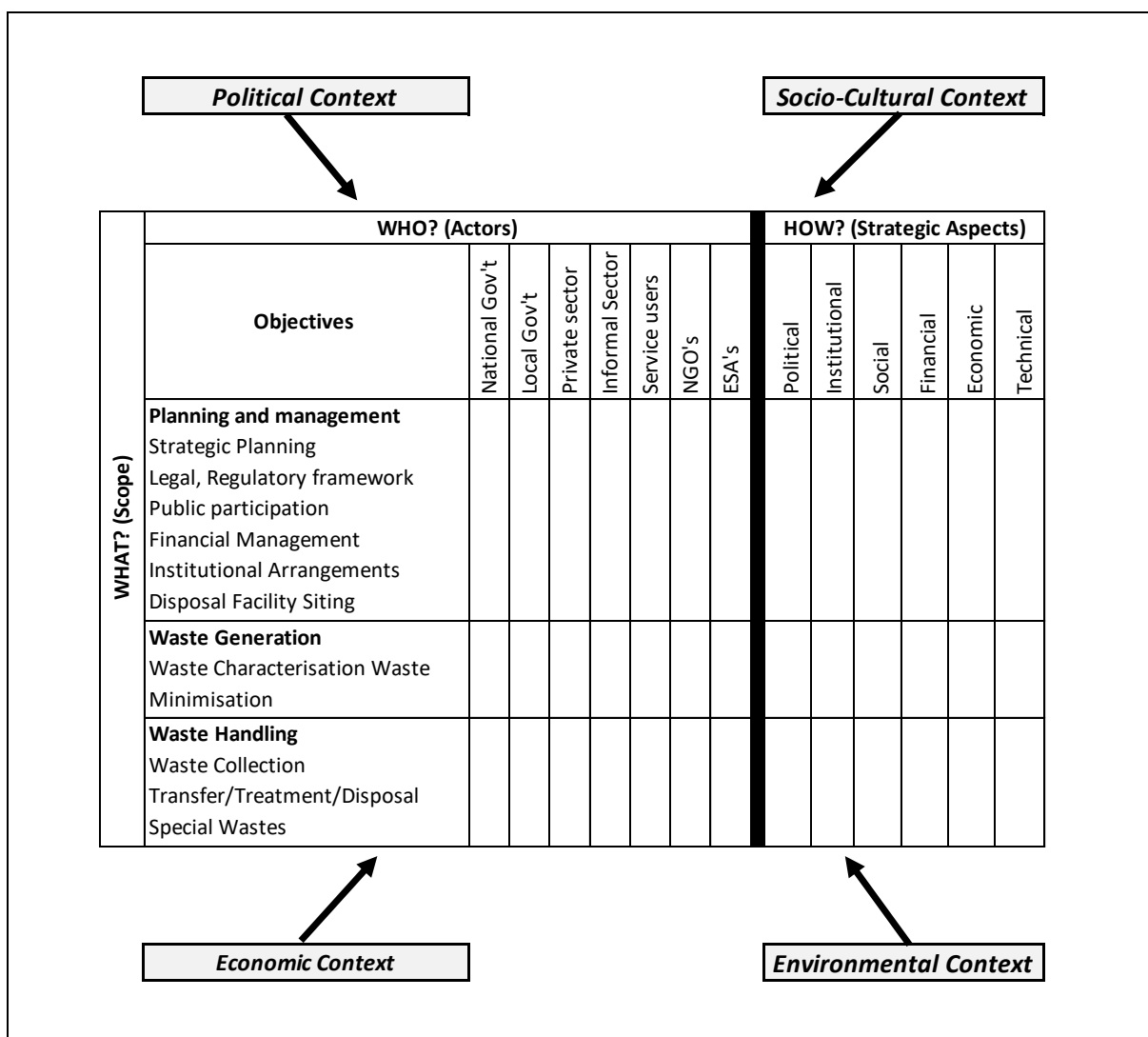
The preference of system sustainability becomes increasingly lower with the waste flows from upstream operations (end user actions) to downstream operations (landfill) through a waste management system. The importance of this theoretical framework of sustainable waste management is thus evident. Upstream operations need more efforts to achieve greater sustainability of waste management. To minimise downstream waste disposal, attention is needed at waste reduction, resource recycling, and energy recovery (Yu et al., 2015:31-32).

E-waste is a hazardous waste and if disposed on normal landfills, the toxic elements will be released in the soil over time due to chemical breakdowns. Disposal through normal landfilling is therefore not an option. In a conceptual framework, the landfilling could be replaced with a hazardous waste facility as a last resort. In a conceptual framework for e-waste management, there also does not seem to be a place for energy recovery or

compressing due to the hazardous nature of the waste. The transport/distribution needs to be a focus point in a conceptual framework as e-waste cannot be mixed with other waste types and transport to recyclers or separation facilities will be important. The entities responsible for the collection, transportation, and distribution need to be determined. The transportation can be municipal entities, private entities, or a combination of the two.

3.9.3 Conceptual model for Municipal Solid Waste Management

Figure 3.3: Conceptual model for Municipal Solid Waste Management



Source: Schübeler, Wehrle & Christen, 1996:17

In Figure 3.3, a conceptual framework for Municipal Solid Waste Management (MSWM) in low-income countries is shown (Schübeler, Wehrle & Christen, 1996:15). Although the focus of this conceptual model is on municipal solid waste management, it addresses special wastes, such as e-waste. The framework focuses on the same core functions as the theoretical framework, e.g. collection, treatment (pre-processing), transfer (transport), recycling, and disposal. Although the conceptual framework is not e-waste specific, the literature indicates that special waste types require special measures to manage this kind of waste sustainably. This conceptual municipal framework delves deeper into more dimensions, which could supply more and better answers to the research under investigation. The goals of MSWM are to protect environmental health, to promote the quality of the urban areas, to support productivity and the efficiency of the economy, and to generate employment opportunities as well as income where possible (Schübeler, Wehrle & Christen, 1996:18-19). The principles for sustainable waste management strategies are thus to minimise waste generation, maximise waste re-use and recycling, and to ensure the safe and environmentally sound disposal of waste. Except for waste minimisation, the goals and principles should also be the minimum standards for e-waste management. Dimensions from this conceptual framework can therefore be incorporated into a final conceptual framework from where the research can be initiated.

The adaptation to the prevailing context of the city and/or country in which they operate determines the effectiveness and sustainability of an MSWM system. The conceptual framework outlined the political context, the socio-cultural context, the economic, and the environmental context as very important.

The WHAT?

The first dimension in the conceptual framework is the scope (The “WHAT”), which encompasses the following functions and concerns:

- ***Planning and management***

This dimension entails strategic planning, a legal and regulatory framework, public participation, financial management, institutional arrangements (including private sector participation), and disposal facility placing.

- ***Waste generation***

This dimension involves waste characterisation (e.g source, rates and composition), waste minimisation, and separation at source.

- ***Waste handling***

In line with the theoretical framework from Figure 3.3, the focus is on waste collection, waste transfer, treatment and disposal, special waste (medical, small industries, e-waste, etc.) (Schübeler, Wehrle & Christen, 1996:19-20).

The WHO?

The second dimension in the conceptual model is the actors and partners (The “WHO”), which includes a wide range of individuals, groups and organisations who are concerned with MSWM as service providers, service users, intermediaries and/or regulators. They are households, communities and other service users, non-Governmental organisations, local Government, national Government, private sector enterprises, and the informal Private Sector (waste collectors) (Schübeler, Wehrle & Christen, 1996:20-24).

The HOW?

The third dimension in the conceptual framework is the strategic aspects (The “HOW”) and this implies that appropriate measures be taken after specific objectives have been formulated regarding a range of strategic aspects. They are:

- ***Political aspect***

Firstly, the goals and priorities of MSWM and that of the public must be determined; secondly, the role and jurisdiction of authorities must be outlined; lastly, there must be a legal and regulatory framework, which directs government structures.

- ***Institutional aspects***

For MSWM, a decentralised system where responsibilities are distributed are proposed. The involvement of the private sector and the participation of users can change the role of government institutions to regulation instead of service delivery. Waste collection could be decentralised to the communities themselves and informal waste collection could support service delivery.

- ***Social aspects***

Waste generation and disposal patterns are conditioned by people's attitudes, which can be positively influenced, while the participation of the users are essential for MSWM. Informal waste collectors could contribute to waste collection, recycling and re-use, but are subject to serious health risks that should be managed.

- ***Financial aspects***

To manage solid waste systems effectively, adequate budgeting, cost accounting, financial monitoring, and financial evaluations are essential. Operating expenses are needed and normally collected from charges to the user of the solid waste. For financial sustainability cost reduction/minimisation and control is needed, which implies better utilisation of available resources.

- ***Economic aspects***

With an increase in economic development, solid waste generation and service demand also increases. To encourage waste recovery and re-use, new policies must be introduced. This will ensure employment and income generation.

- ***Technical aspects***

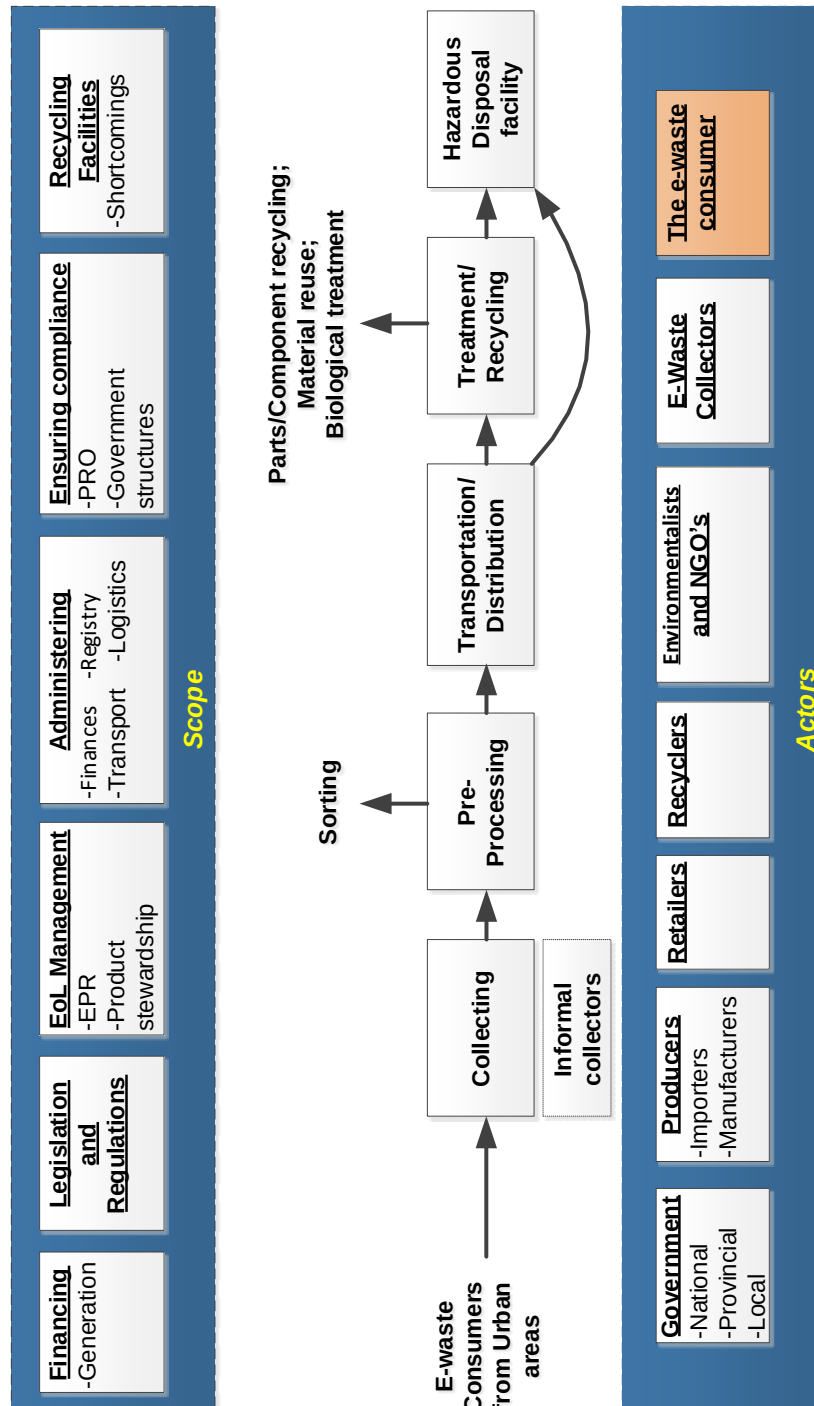
The technical systems for collection, storage, transport, treatment and final disposal must be suited for the operational requirements of the city. Collection systems comprise of containers, collections vehicles and equipment, and the organisation and equipping of collection workers. The local collection systems and the transfer facilities and equipment must be a match. This includes temporary waste storage and transfer points, vehicles and equipment for waste transfer, and the operating procedures for doing maintenance. The sanitary landfill disposal is the most appropriate method of final waste disposal, but hazardous wastes must be directed to hazardous waste sites (Schübeler, Wehrle & Christen, 1996:27-50).

3.9.4 Conceptual framework for the current study

From the literature consulted, the theoretical framework of sustainable waste management system (From Yu *et al.*, 2015:31), and the conceptual model for MSWM (From Schübeler, Wehrle & Christen, 1996:17), a final conceptual framework has been

developed. The conceptual framework will guide the research process by focusing on key factors as applied in South Africa.

Figure 3.4: Conceptual framework for a South African e-waste management system



Source: The researcher

The middle section of the proposed conceptual framework was informed by the upper section of the theoretical framework of Yu *et al.* (2015:31). The conceptual framework proposes a “Hazardous Disposal Facility” as a final disposal method, whereas the theoretical framework of Yu *et al.* (2015:31) had “Landfill” as a last resort. The difference is due to the hazardous nature of e-waste that cannot end up in landfills. E-waste needs to be collected, sorted, transported, recycled (or treated), and as a final step, it must be disposed at a hazardous disposal facility.

- ***Actors/stakeholders in the conceptual framework***

The conceptual framework of MSWM indicated some actors/stakeholders, which corresponds with what is needed in an e-waste management study. The stakeholders identified in the conceptual framework are government structures, producers (importers/manufacturers) of EEE, EEE retailers, e-waste recyclers, NGO’s (including environmentalists), e-waste collectors, and e-waste consumers. The stakeholders are directly involved with the challenges posed by e-waste, either by importing/manufacturing EEE, selling EEE, generating e-waste, collecting e-waste, or effectively disposing of e-waste. The stakeholders, excluding consumers, are experts in their respective fields and their knowledge and experiences in the e-waste field should contribute to what is needed in South Africa to manage e-waste effectively.

- ***The South African urban e-waste consumer***

The centre point of the current research starts with consumers having electrical equipment that has come to the EoL stage. E-waste needs firstly to be moved from consumers’ homes into the suitable disposal chain. Consumers’ attitude towards e-waste, their norms, planned behaviour control (as influenced by perceptions of convenience and cost of recycling payment of advance recycling fees and receiving point rewards system) must be determined. To determine the view of different urban consumers, an online survey seems to be the most appropriate method. A large numbers of consumers can be surveyed, from different cities, which will give statistical significant results. The analysis of the data will indicate which route to follow to motivate South African consumers to dispose of e-waste correctly and effectively. In Chapter 4, the theoretical and conceptual framework for conducting the quantitative study will be discussed in detail.

The quantitative research question that will be addressed via a survey with urban consumers is:

What are the drivers and inhibitors of e-waste recycling behavioural intention of South African consumers?

The research question will be answered through statistical analysis of a survey with urban consumers in South Africa. Hypotheses will be formulated in the next chapter and analysis of the data will prove or disprove support for the assumptions in Chapter 7.

- **Government sector**

The Government sector comprises of National Government (The Department of Environmental Affairs), Provincial Government, and Local Government. National Government initiates legislation to guide environmental protection. The Provincial Government uses the legislation as guidelines in their provinces to ensure that appropriate actions are taken by Local Government (municipalities), as they are the implementers of the guidance from Provincial Government. Bylaws are used to attempt to implement the legislation. These three entities are politically affiliated and could be from different political parties. There are challenges with this arrangement, and insight could be gained by having in-depth discussions with e-waste specialists within these structures. The role of National Government is critical, as they will have to give direction to Provincial and Local Government. The role of Local Government as possible e-waste collectors and distributors needs to be investigated.

- **Producers**

Importers and manufacturers have to play an integral role in an e-waste management system. Suppliers of EEE have access to information regarding correct recycling procedures, have direct contact with retailers, and can be regarded as the originators of e-waste pollution in South Africa. Discussions with producers should reveal valuable information, which can be used to develop an e-waste management framework.

- **Retailers**

Retailers are the point of contact between producers and consumers. Their interaction with the public and the potential of being a collection point needs to be investigated.

Discussions with this group in the value chain should also contribute to the e-waste management framework.

- ***Recyclers***

Recyclers (possibly refurbishers) play a very important role in the disposal chain of e-waste. Recycling/refurbishing is preferred to disposal as the product life can be extended, components can be re-used, and the need to use raw material can be decreased. Recyclers can shed light on best practices in countries that are e-waste recycling leaders, point out where there are shortcomings in South Africa, and give valuable inputs on the composition of an e-waste management framework.

- ***Environmentalists and NGO's***

Environmental specialists as well as NGO's are concerned with environmental health as it has an impact on the health and safety of the public. Specialists who have an e-waste focus could thus indicate problematic recycling areas and provide valuable information on an e-waste management framework.

- ***E-waste collectors and informal collectors***

The focus will be on established collectors for e-waste recyclers, and not discussions with informal waste pickers. Waste collectors can provide information of collection problems, especially for large household types, and contribute to the research. Informal waste collectors play a large role in South Africa in collecting plastics, paper, glass, etc. Discussions with all the role players will indicate which role they will play in e-waste collection.

- ***The scope of a management framework***

From the literature and the conceptual framework for MSWM, the scope of what needs to be included in the current research is identified in the top row of the conceptual model. This focus is to ensure that e-waste is collected, pre-processed, transported, recycled, and disposed (the middle section of the conceptual framework). The stakeholders to be interviewed need to give guidance on what items within the scope each stakeholder should focus on.

- ***Financing***

To run a management system effectively, finance is needed. Stakeholders will be probed to explore their views on which income generation method will be appropriate. Financing options include fees paid by consumers, producers, government subsidies, and special taxes paid by the general tax payers.

- ***Legislations and regulations***

From the literature, it is evident that legislation and regulations are available but limited. The interviews with key stakeholders could explain if the legislation is enough and if dedicated e-waste legislation is needed. The role of stakeholders in developing legislation can also be established.

- ***End of Life (EoL) Management***

The South African environmental act stipulates that priority should be given to e-waste to investigate the implementation of EPR further. Key stakeholder inputs will be obtained to investigate the suitability of different management tools (e.g. Product Stewardship versus EPR).

- ***Administering***

Any system excels or falls by the way it is administered and managed. The proper administering of the finances will ensure sustainability. The administering of transport and logistical issues will ensure the removal of e-waste, while the administering of a registry will ensure there are minimum free riders in the e-waste management system. The key stakeholders interviewed will shed light on who should be responsible for administering the different functions.

- ***Ensuring compliance***

Linked to the previous point is the entity who must ensure compliance. Someone must take the responsibility to ensure a proper e-waste management system for household goods; this could be producer organisations, government, or a combination of the two or more stakeholders.

- **Recycling facilities**

As part of the e-waste industry, stakeholders will be able to indicate where shortcomings are in the recycling environment. They will also be able to indicate what needs to be done to address the shortcomings.

The stakeholders/actors' inputs, which are needed in the research process, have been identified in the preceding sections. Interviews with different stakeholders will provide rich and in-depth feedback. This can be used to develop an e-waste management framework, as it will give guidance of what needs to be changed and what structures are needed to implement such a system.

The following research questions will be used as a basis to extract information from stakeholders:

Research question 1a:

What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on the collection of e-waste from household consumers?

Research question 1b:

What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on e-waste distribution to recyclers?

Research question 1c:

What are the views of key stakeholders on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

3.10 CONCLUSION

Chapter 3 gave an overview of literature related to e-waste management in South Africa. The e-waste landscape and material flow in South Africa were presented. An overview of current mechanisms to co-ordinate and drive the e-waste management processes in South Africa have been discussed – specifically, EPR, stakeholder responsibility, systems coverage and ensuring compliance and registry of e-waste. E-waste legislation,

collection of e-waste and financing models for recycling e-waste were presented. The chapter was concluded with a discussion of WEEE design and treatment systems and factors restricting e-waste management effectiveness in a South African context. The next chapter looks at the consumer, as they are crucial stakeholders in possession of the EoL equipment. Chapter 4 present will show a conceptual framework that was derived from research conducted around the globe.

CHAPTER 4: GREEN MARKETING A WAY TO GREEN ECONOMY AND THE THEORY OF PLANNED BEHAVIOUR (TPB)

4.1 INTRODUCTION

A South African perspective on e-waste management was offered in the previous chapter. The purpose of this chapter is review green marketing as a way to obtain a green economy and to discuss the TPB applied to WEEE recycling research. The theory informing the development of the nine hypotheses in the current study is presented. This will be done by firstly discussing the determinants of e-waste recycling behaviour intentions based on the TPB. Secondly, relevant literature on rewards and penalties to promote e-waste recycling behaviour is presented. Thirdly, demographical variables related to e-waste recycling behaviour intentions are reviewed. This chapter is concluded by the presenting the proposed model for this South African e-waste study.

4.2 GREEN MARKETING A WAY TO GREEN ECONOMY

4.2.1 The meaning of green growth and green economy

The terms green growth and green economy can be defined in different ways. It might therefore be sensible to review the descriptions used by prominent international organisations promoting green growth knowledge and measurements. Table 4.1 indicates several definitions provided in key literature published on the green economy and green growth by prominent organisations (e.g. United Nations Environment Program (UNEP), International Chamber of Commerce (ICC), United Nations Conference on Trade and Development (UNCTAD), World Bank, Global Sustainability Panel, Organisation for Economic Cooperation and Development (OECD), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and Global Green Growth Institute (GGGI)).

Table 4.1: Definitions of green economy and green growth

Green economy • A green economy is as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2012). • An economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress on social development (ICC, 2012). • The green economy involves largely new economic activities and must provide an important entry-point for Broad-Based Black Economic Empowerment, addressing the needs of women and youth entrepreneurs and offering opportunities for enterprises in the social economy (South African Government, 2011). • An economy that results in improved human well-being and reduced inequalities, while not exposing future generations to significant environmental risks and ecological scarcities. It is an enabling component of the overarching goal of sustainable development (UNCTAD, 2012). • Is the new revolutionary development paradigm that sustains economic growth, while at the same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished (GGGI, 2019). Green Growth • Efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. And this growth needs to be inclusive (World Bank, 2019). • Green growth aims to foster economic growth and development while ensuring that natural assets and environmental services are protected and maintained. Is about recognising, understanding and acting on interconnections between the economy, society and the natural environment (GSP, 2012). • Fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. (OECD, 2019b). • A policy focus for the Asia and the Pacific region that emphasises environmentally sustainable and socially equitable development (UNESCAP, 2019).

Source: Organisations cited in the table.

Overall, these different definitions seem to be generally consistent and emphasise that the ultimate objective is economic development that is efficient and sustainable in the use of natural resources and minimises negative environmental externalities, while aiming at advancing the general welfare of humanity and broader society. E-waste contains complex hazardous elements and is at present one of the largest growing waste streams globally (Gupta, 2014:204). If incorrectly managed or processed by informal or unregulated enterprises, it can damage consumers' health and the environment. However

Careful and efficient, e-waste management is an essential element for conserving the environment and maintaining environmental sustainability; it could contribute to objectives of a green economy and green growth. When recovering valuable raw materials and re-usable parts it can lead to substantial value while accompanying emission savings. Globally, 48.5 million annual tons e-waste was produced in 2018 and in 2021, a volume of 52 million tons is expected. The economic value in e-waste is often unappreciated, specifically from materials such as gold, silver, copper, platinum and palladium. The quantifiable annual value of e-waste is estimated to be worth \$62.5 billion; three times more than the annual earnings of the world's silver mines and higher than the Gross Domestic Product of most countries (Pace, 2019:15).

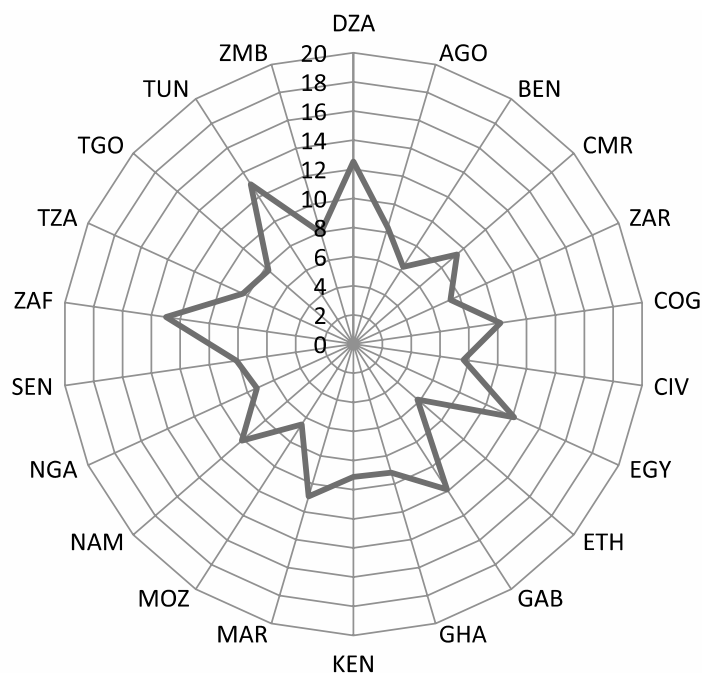
Evidence has shown that the greening of economies does not constrain wealth creation or employment opportunities. A green economy is thus not a luxury only for wealthy countries as there are various examples of conversions to greening taking place in several sectors in developing countries (UNEP, 2011b:1-2). Rising living standards and economic growth go hand in hand with increased waste generation. Resource recovery and efficiency is needed to reduce waste flows.

4.2.2 Green economy indicators

Kararach *et al.* (2016:445) developed an African Green Growth Index (AGGI) in an attempt to provide a standard benchmark to assess green growth transition across the African continent. This index applied 48 indicators to 22 countries with the required data available. A visual presentation of the ranking of the countries based on this index is displayed in Figure 4.1. It can be seen that 18 out of the 22 African countries assessed, obtained an index of 50 percentage points and higher. Countries that performed the best included Namibia, Zambia, Ghana, Tanzania and Togo.

The following five countries obtained less than 50 percentage points on the index: Egypt, Algeria, Nigeria and South Africa.

Figure 4.1: Green Growth Index for selected African countries



Countries and their country codes (per World Bank)

1. Algeria (DZA)	9. Ethiopia (ETH)	17. Senegal (SEN)
2. Angola (AGO)	10. Gabon (GAB)	18. South Africa (ZAF)
3. Benin (BEN)	11. Ghana (GHA)	19. Tanzania (TZA)
4. Cameroon (CMR)	12. Kenya (KEN)	20. Togo (TGO)
5. Congo, Dem. Rep. (ZAR)	13. Morocco (MAR)	21. Tunisia (TUN)
6. Congo, Rep. (COG)	14. Mozambique (MOZ)	22. Zambia (ZMB)
7. Côte d'Ivoire (CIV)	15. Namibia (NAM)	
8. Egypt, Arab Rep. (EGY)	16. Nigeria (NGA)	

Source: Kararach et al., 2016:445

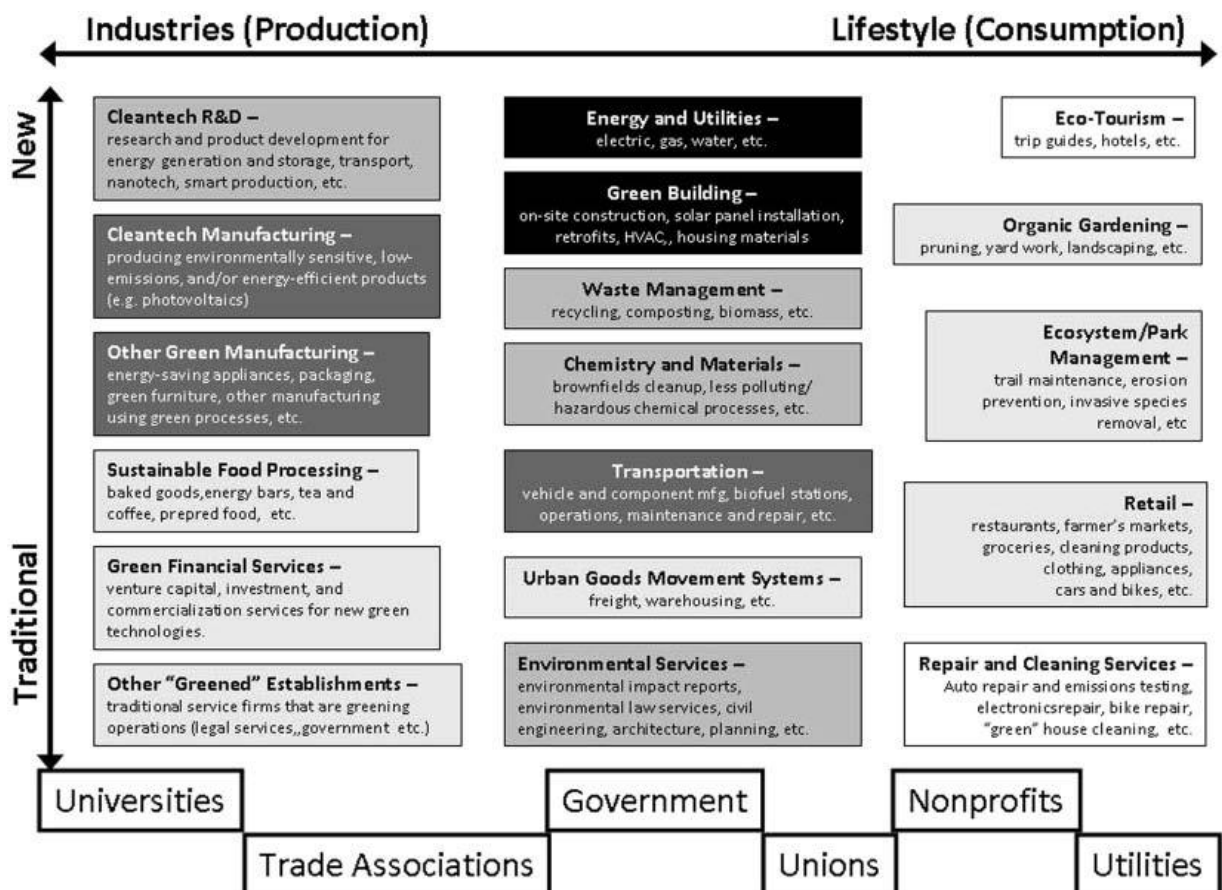
The South African Government is slowly realising this predicament and is attempting to address the low performance of our green economy. The South African Government supports investment into a green economy approach and developed a model similar to the Green Economy Report (GER) (UNEP, 2011b; UNEP, 2013:6). South Africa's vision for sustainable development is to protect its democracy by responsibly managing the limited ecological resources and by providing for the basic needs of the existing and future population. This can only be attained through effective planning, which is integrated through global, national, and regional collaboration.

South Africa aims to incorporate green economy principles to ensure sustainable development, economic prosperity and to be a self-reliant state (UNEP, 2013:10).

4.2.3 The position of the E-waste industry in the green economy

Chapple *et al.* (2011) conducted a systematic review of published reports by key role players to develop a taxonomy of the green economy. This taxonomy includes 18 different industry sectors, as seen in Figure 4.2.

Figure 4.2: Taxonomy of the green economy



(Source: Chapple *et al.*, 2011:8)

Different shades are used in the figure to indicate the frequency that each industry sector is cited in these reports. The sectors that have been cited the most are indicated by the darkest shades, while those cited the least are indicated in white.

On the vertical axis the sectors are classified based on their life cycle stage. Sectors are catalogued on the horizontal axis as those that manufacture green products, to those that trade in green products or involved in green-lifestyle economy.

It can be seen that waste management (including e-waste management) is placed relatively high on the vertical axis, implying that it is rather new and still in the early life cycle stage. It is located in the middle of the horizontal axis since this industry involves production as well as consumption features.

The bottom of the diagram suggests that all the industries within the green economy (including e-waste management) engage with and have an impact on government agencies, universities, non-profit organisations, utilities and trade associations.

4.3 GREEN MARKETING

4.3.1 The meaning of green marketing

Different terms are used when referring to green marketing such as greener marketing, environmental marketing, ecological marketing, sustainable marketing and even responsible marketing (Peattie & Crane, 2005:369). The green marketing concept was originally introduced to marketing practitioners and academia at a conference on “ecological marketing” organised by American Marketing Association (AMA) in 1975. This ecological or green marketing concept centred on negative and beneficial effects of marketing on environmental pollution, energy consumption and consumption of other resources (Boztepe, 2012).

Polonsky (2011:1310) asserted that green marketing was an exchange process (i.e., choices and decisions), with specific conditions that exchange considers and minimises environmental harm.

Boztepe (2012:10) emphasized that green marketing serves a dual-purpose, namely:

- To deliver and design appealing consumer products and service, environment-friendly products causing minimal damage at affordable prices are needed.

- In order to reflect an image of high quality, environmental sensitivity and hence production of products compatible with environment are required.

Following a stakeholder approach within green marketing emphasises that all stakeholders – consumers, companies and governments - are interrelated (Polonsky, 2011:1311) and the stakeholders have the ability to facilitate or impede green marketing from becoming transformational.

4.3.2 Failure of green marketing

The critical review by Dennis *et al.* (2005:369) over two decades concluded that green marketing theory and practice are often supported by neither a marketing, nor an environmental philosophy. They found five types of misconceived green marketing that can lead to green marketing failures, namely:

- *Green spinning* is public relation offensive campaigns often applied by “dirty” industries, such as oil, chemicals, pharmaceuticals, and automotive, in attempt to convince the cynical public members of their environmental credentials.
- *Green selling* is the post-hoc adding and promotion of environmentally friendly features in existing products rather than developing actual new greener products. This short-term approach resulted in widespread consumer cynicism due to consumers not seeing any real difference in so-called “green products.”
- *Green harvesting* occurs when marketers are suddenly concerned about the environment if greening could lead to cost savings and increased profits, for example using less packaging.
- *Enviropreneur marketing* occurs when focusing on manufacturing the most environmentally benign products, while failing to properly research and understand key products features required by consumers or educating their customers. This often leads to consumers that perceive environmentally-friendly products as under-performing and over-priced.
- *Compliance marketing* is used by companies who comply with the environmental legislation just to promote their green credentials.

4.4 THE THEORY OF PLANNED BEHAVIOUR (TPB)

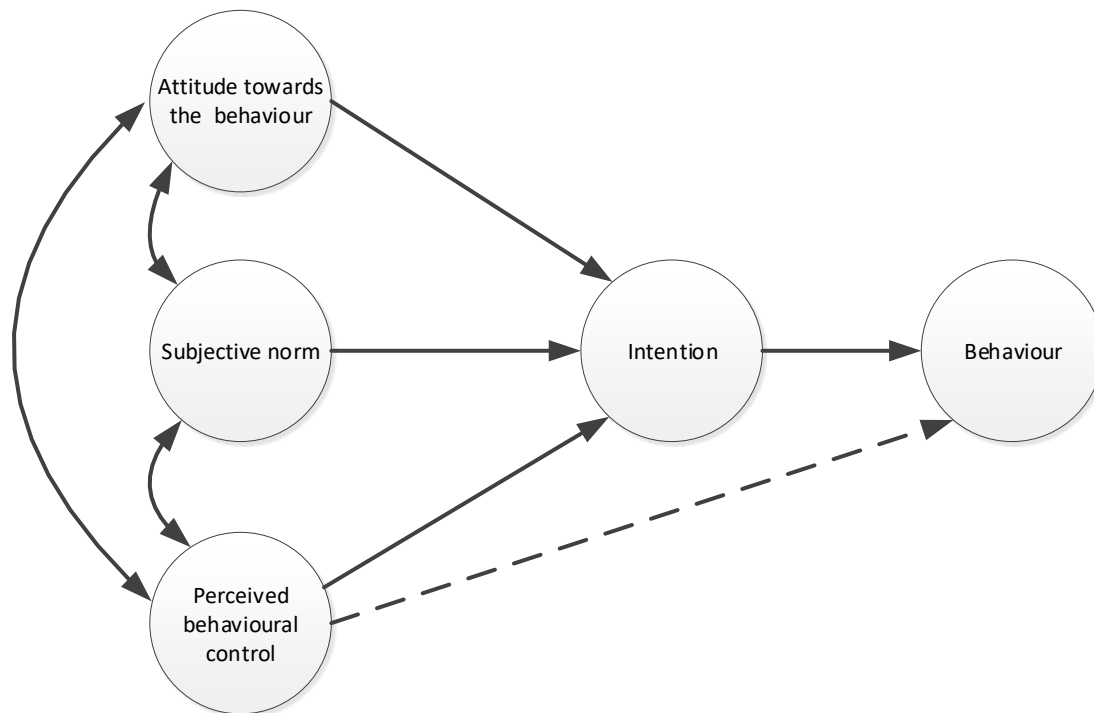
Different models have been recommended to examine pro-environmental behaviours. The two most prevalent, which serve as the foundation for several other theories, are Schwartz's' Altruism Model (Schwartz, 1977:221), which considers environmental conservation actions by favourable personal norms, and the "Theory of Planned Behavior" (TPB) (Ajzen, 1991:179). This study applied the TPB model because the TPB has been proven superior to AM in predicting consumers' long-term recycling commitment in a developing context (Chaisamrej & Zimmerman, 2014). Furthermore several other studies on WEEE guided by the TPB (Echegaray & Hansstein, 2017; Hansmann *et al.*, 2006; Nguyen *et al.*, 2018; Nixon & Saphores, 2007; Saphores *et al.*, 2012; Tonglet *et al.*, 2004; Wang *et al.*, 2016; Ylä-Mella, Keiski & Pongrácz, 2015; Zhang *et al.*, 2016; Zhong & Huang, 2016) have been published in prominent journals.

A major challenge often faced when aiming to get consumers to behave in an environmentally friendly or green manner is the green attitude-behaviour gap, i.e., the low relationship between consumers' attitude and their actions or actual behaviour (Joshi & Rahman, 2015:128). An approach to overcome this gap is the application of the TPB, since it does not deduce from attitude to behaviour directly. The TPB is an extension of the theory of reasoned action (TRA), which did not take into account the contributing factor of Perceived Behavioural Control (PBC) (Ajzen, 1991). The differentiation between these two theories is that the TPB has integrated PBC as the determining factor of behavioural intention and control beliefs, which have an effect on the PBC.

The TPB model is regarded as a cognitive social psychology theory, which has been developed and applied to explain human-decision-making processes (Wang *et al.*, 2007:296). The TPB is one of the theories most frequently draw on to analyse pro-environmental behaviour (Bamberg & Möser, 2007:14). This theory has been verified to be able to explain and predict green consumer behaviour, such as eco-friendly activities performed by tourists (Han *et al.*, 2010:325; Lee *et al.*, 2010:901), intention of consumers' towards buying green products (Chaudhary & Bisai, 2018:798; Lizin *et al.*, 2017; Paul *et al.*, 2016:123; Yadav & Pathak, 2016:732; Yadav & Pathak, 2017:114) and household waste recycling behaviours (Chan, 1998:317; Nigbur *et al.*, 2010:259; Tonglet, Phillips & Read, 2004:191).

An individual's behaviour is a product of analytical process, which is influenced by three fundamental components: attitudes, subjective norms, and PBC (Pickett *et al.*, 2012:339). The fundamental components are the core of the TPB model.

Figure 4.3 Theory of planned behaviour



(Source: Ajzen, 1991:182)

The TPB is based on the presumption that behaviour is determined by behavioural intentions, which in turn are affected by attitudes, social norms and PBC. Figure 4.3 graphically represents these relationships in the TPB model. The TPB has played an influential role in predicting human social behaviour since introduced more than three decades ago (Ajzen, 2011:1113). According to the TPB model, a consumer's behaviour is a product of a rational decision-making process, which is influenced by the three fundamental components:

- *Attitude toward the behaviour.* This refers to the degree to which a person has an appraisal or a favourable or unfavourable evaluation of the behaviour in question (Ajzen, 1991:188). It is further conceptualised as a positive or a negative evaluation of executing a specific behaviour. If a person has a positive attitude towards a specific behaviour, then the tendency to engage in the behaviour will be high if he/she believes

that a positive outcome will be the result of the behaviour being performed (Sentosa & Mat, 2012:64).

- *Norm*. The original TPB included *subjective norms*, which are social factors and refer to the perceived social pressure a person experiences to perform or not to perform the behaviour. It takes into consideration the approval or disapproval of peer groups if one engages in a specific behaviour (Ajzen, 1991:188; Sentosa & Mat, 2012:65).
- *Perceived behavioural control*. This is assumed to reflect on past experiences as well as anticipated weaknesses and obstacles. It also refers to the consumers' perceived difficulty or ease of performing the behaviour based on an individual's belief of the availability of resources required to perform the given behaviour (Ajzen, 1991:188; Sentosa & Mat, 2012:65).

The general rule is that a consumer's intention to perform the behaviour under consideration will be stronger should there be a more favourable attitude and subjective norm towards the behaviour, and the greater the PBC. In the prediction of behavioural intention, the relative importance of attitude, subjective norm, and PBC is expected to vary across behaviours and situations. It is thus possible that in some applications only attitude has a significant impact on intentions, while in other applications attitude and PBC are the only two having a sufficient impact on intentions. In other studies, all three predictors could contribute independently (Ajzen, 1991:189).

4.5 THE THEORY OF PLANNED BEHAVIOUR (TPB) APPLIED TO WEEE RECYCLING RESEARCH

4.5.1 Past research on WEEE recycling

Several previous studies on WEEE recycling have been carried out. In this section these will be reviewed briefly while focusing on research that is relevant to the quantitative phase of the current mixed methods study. Table 4.2 summarises selected studies that relate to this study's constructs.

Table 4.2: TPB model applied to consumers WEEE recycling

Source	Study theme	Key findings
Developed context		
Hansmann, Bernasconi, Smieszek, Loukopoulos & Scholze, (2006)	Justifications and self-organization as determinants of battery recycling behaviour in Switzerland	Recycling knowledge, self-organization of recycling, and disagreement with justifications for non-recycling were positively related to recycling behaviour, while attitudes towards ecological waste disposal and trust in waste disposal authorities were not directly related to respondents' self-reported battery recycling behaviour.
Lizin, Van Dael, & Van Passel, (2017)	Drivers and barriers to battery pack drop-off intention in Belgium	PBC and mora norms have the largest influence on the intention to drop-off used battery packs as quickly as possible
Nixon & Saphores (2007)	Consumers' willingness to pay for an advanced recycling fees for electronics in California, USA	Age, income, beliefs about government and business roles, proximity to existing recycling facilities, community density, education, and environmental attitudes are significant factors for explaining willingness to pay an ARF for electronics. Most respondents are willing to support a 1% ARF.
Saphores, Ogunseitan, & Shapiro, (2012)	Willingness to engage in a pro-environmental behaviour (e-waste recycling) determine by a national survey of U.S. households	Important variables for explaining willingness to recycle e-waste are internal variables, followed by recycling convenience, knowledge of the potential toxicity of e-waste, and prior e-waste recycling experience. Education, age, and ethnicity play only a minor role, while knowledge of e-waste laws, availability of curbside recycling for domestic waste, and income are not statistically significant.
Tonglet, Phillips & Read, (2004)	Determinants of recycling behaviour: a case study from Brixworth, UK.	Pro-recycling attitudes were the major contributor to recycling behaviour. Attitudes are influenced by having the appropriate opportunities, facilities and knowledge to recycle, and by not being deterred by the issues of physically recycling. Significant predictors of recycling behaviour are past recycling experience, and a concern for the community and the consequences of recycling.
Ylä-Mella, Keiski, & Pongrácz, (2015)	Consumers' perceptions towards recycling and re-use of mobile phones in Finland	Consumers' awareness of the importance and existence of waste recovery system is high; however, it has not translated to recycling behaviour. Proximity and the convenience of current waste management system are inadequate in promoting the return of small WEEE.

Table 4.2: TPB model applied to consumers WEEE recycling (continued)

Developing context		
Source	Study theme	Key findings
Echegaray & Hansstein, (2017)	Assessing the intention-behaviour gap in electronic waste recycling: the case of Brazil	Overall respondents hold a positive intention towards recycling electronic appliances. Favourable views of recycling and the perceived social acceptance of recycling significantly explain the intention to recycle. A minority adopts adequate recycling practices connected to e-waste.
Nguyen, Hung, Lee, & Nguyen, (2018)	Determinants of residents' e-Waste recycling behavioural intention of six kinds of common e-waste in Vietnam	Environmental awareness and attitude toward recycling, social pressure, laws and regulations, cost of recycling, and inconvenience of recycling significantly directly affected residents' behavioural intention.
Wang, Guo, & Wang, (2016)	Determinants of residents' e-waste recycling behaviour intentions: Evidence from China	Environmental awareness and attitude toward recycling, social pressure, laws and regulations, cost of recycling, and inconvenience of recycling significantly directly affected behavioural intention Laws and regulations are the strongest construct significantly to predict intention. Only inconvenience of recycling had a negative impact on recycling behavioural intention.
Zhang, Zhang, Yu, & Ren, (2016)	What keeps Chinese from recycling: accessibility of recycling facilities and the behaviour.	A significant gap between behavioural intention and actual recycling behaviour. Lack of effective recycling facilities constitutes an obstacle that keep consumers from sorting and reusing recyclable wastes. Accessibility of recycling facilities could lower behavioural costs and encourage people to take that action.
Zhong & Huang, (2016)	Consumers' willingness to participate in E-waste recycling with a PRS in China	There is a significant correlation between the influence of a willingness to participate in formal E-waste recycling and participating expectancy, subjective attitude, objective environment, and few special consumer characteristics.
Borthakur & Govind (2018)	Public understandings of E-waste and its disposal in urban India	Attitude and subjective norms have a positive influence on E-waste disposal intention. PBC is not a considerable predictor of E-waste recycling behaviour

Table 4.2 summarises a number of the studies that have been done on WEEE consumers and guided by the TPB. These include studies about consumers in developed markets such as Switzerland (Hansmann *et al.*, 2006), USA (Nixon & Saphores, 2007; Saphores *et al.*, 2012), UK (Tonglet *et al.*, 2004), Belgium (Lizin *et al.*, 2017) and Finland (Ylä-Mella, Keiski & Pongrácz, 2015; *et al.*, 2015). It also includes research conducted in developing markets such as Brazil (Echegaray & Hansstein, 2017), Vietnam (Nguyen *et al.*, 2018) and China (Wang *et al.*, 2016; Zhang *et al.*, 2016; Zhong & Huang, 2016). Studies in the developed countries, Switzerland, Belgium, America, United Kingdom, and Finland, revealed a positive attitude and a culture of recycling habits towards household e-waste recycling. The underlying factors which support this culture are moral norms, e-waste recycling experience and knowledge, facilities, opportunities, and awareness levels. These supporting factors can only be obtained through awareness programs, regulations and laws, media involvement, and a supporting system through which household e-waste can be collected. A positive attitude towards a recycling fee is also a result of the implemented measures. The studies in developing countries, Brazil, Vietnam, China, and India revealed that laws, regulations, subjective norms, and attitude are strong predictors for effective household recycling. The biggest contributors to failure in collecting household e-waste is inconvenience and a lack of facilities. In South Africa the facilities are limited and inconvenient, legislation is confusing, media involvement is limited, e-waste recycling experience is minimum, and there is no active supporting system to effectively collect household e-waste. The urgent need for research to determine a framework for the South African scenario is thus evident.

4.5.2 Constructs included in past WEEE recycling studies

The original TPB model included three constructs as described (see Section 4.4). The studies where the TPB were applied (see Table 4.2) adopted it to examine e-waste in a specific context and added some other constructs. The following are some examples:

- The study by Tonglet *et al.* (2004:206) included the following constructs in the original three factor TPB model:
 - Moral norms of consumers
 - Situational factors of recycling
 - Outcomes of recycling
 - Consequences of recycling

- Concern for the community
- The conceptual framework of Echegaray and Hansstein (2017:184) added the following constructs to the original three factor TPB model:
 - Socio-demographic and socio-economic factors
 - Awareness towards the environmental problems
 - Environmental assessment
- The study by Ylä-Mella, Keiski & Pongrácz (2015:375) was based on the TPB model, but in their study they focused specifically on the following factors:
 - The recycling behaviour of respondents and the current situation
 - The consumer awareness related to WEEE recovery and legislative issues
 - The respondents' perceptions and attitudes towards re-use of mobile phones
- The work of Zhong and Huang (2016:476) was also based on the TPB model. Their focus was aligned to 1) the willingness of consumers to participate in formal recycling and, 2) the willingness of participants to participate in an e-waste recycling initiative with a points rewards systems (PRS). The following constructs were incorporated in their model:
 - Consumers subjective attitudes
 - Objective recycling circumstances
 - Consumer characteristics
 - Participation expectation
 - Participation valence
- The conceptual framework of Wang, Guo and Wang (2016:853) considered the effect of consumers' demographic characteristics based on the original three constructs of the TPB model and included perceptions of informal recycling, income and costs of recycling.

4.5.3 Constructs included in the current study

The current study relied on the TPB as guiding theory, and incorporated the following three determinants of e-waste recycling behaviour intentions:

- Attitude towards the behaviour
- Norms
- Perceived Behavioural Control

The current study did not examine social norms or descriptive norms, which are the visible behaviour of others. It examined consumers' complying with injunctive norms or shared rule of conduct. This is aligned with the operationalising, following in the study by Nigbur, Lyons and Uzzell (2010:282) and guided by the norm focus theory. According to the norm focus theory, the injunctive norm is linked to sanctioning groups (such as the laws and regulations by the Government and publicity by the media), whereas the descriptive norm is tied to a location (such as neighbourhood groups wanting consumers to recycle) (Cialdini, Kallgren & Reno, 1991:201).

This study also considered the following rewards and penalties mechanisms to promote e-waste recycling behaviour:

- PRS to reward e-waste recycling behaviour
- Advanced recycling fee (ARF) to finance e-waste recycling behaviour

These constructs on consumers' perceptions regarding recycling fees and participation in PRS have been tested by other researchers in a developing context (Yin, Gao & Xu, 2014:519; Zhong & Huang, 2016:478), but not yet in South Africa. The rationale for including these two constructs is that South Africa is a third world country with yearly disposable income per capita of 6323 USD, an unemployment rate of 24.4% (close to 30% in 2019) and 50% of the population living below the poverty line (World Consumer Income and Expenditure Patterns, 2013). Consumers from lower economic groups regard WEEE items as having some form of monetary value (Borthakur & Govind, 2018:1056). Consumer attitudes regarding a reward system, financially or otherwise, and the willingness to pay for recycling have therefore also been tested in the current study.

The following demographical consumer characteristics were also examined:

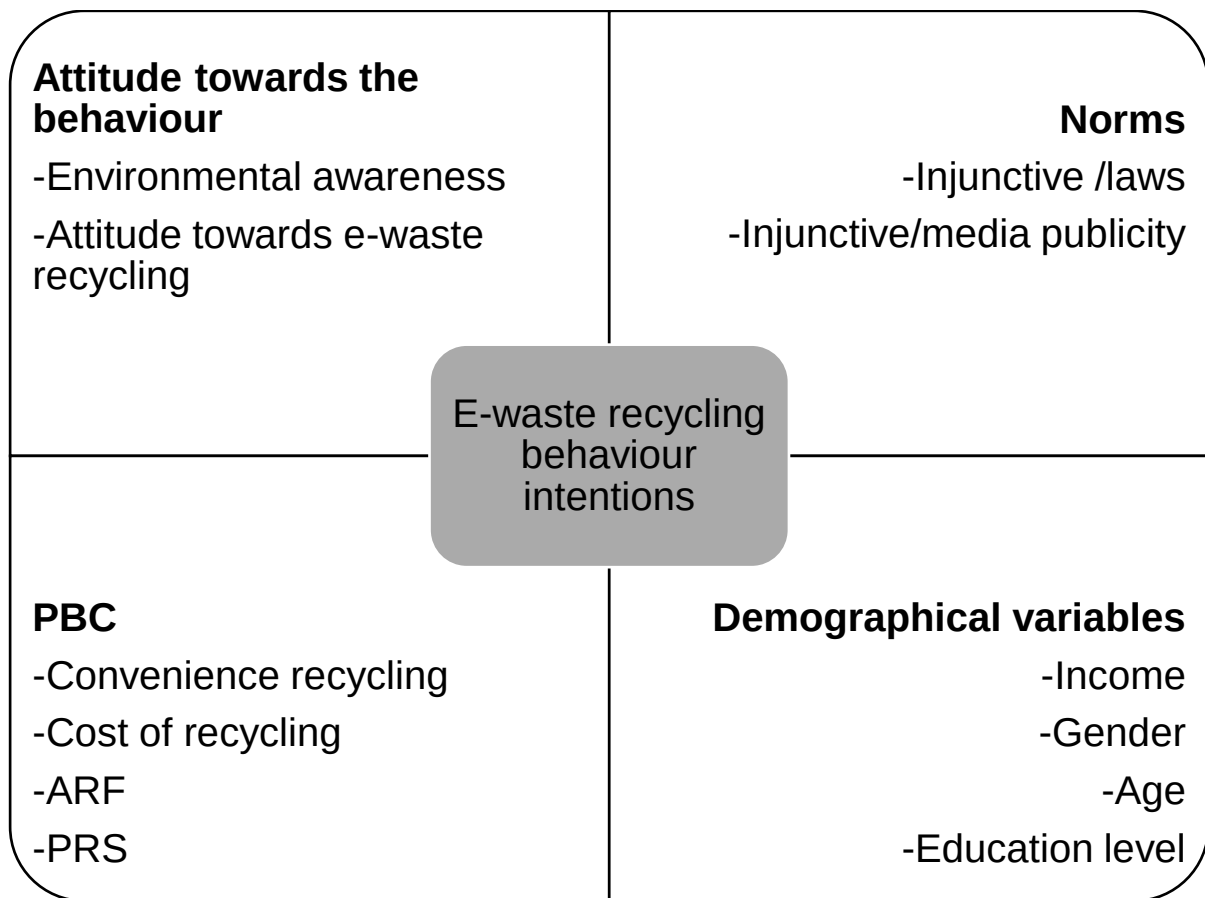
- Income
- Gender
- Age
- Education level

Demographical consumer characteristics were included to determine the current unknown behavioural intentions regarding e-waste disposal of a convenience sample of adults, 18 years and older who resided in urban areas of South Africa, and who have used any type of electronic or electrical equipment in the past year. The sample is not a representative sample of South African e-waste consumers as time and funding did not allow this. Due to limited data on this topic, the question could shed light on current and future preferred disposal methods. Statistical analysis could reveal if the construct has internal consistency and any relation with behaviour intention.

4.6 HYPOTHESES DEVELOPMENT

Figure 4.4 displays a model illustrating the proposed hypotheses to guide the quantitative phase of the current study. The aim is to extend the body of knowledge on South African consumers' e-waste behaviour with regard to the understanding the relationships between constructs that contribute to positive e-waste behaviour intentions. This model guided research objective 2, including hypotheses one to nine, and will help to identify the drivers and inhibitors of South African household e-waste consumers. This will ultimately assist in the development of an e-waste framework to effectively manage e-waste in the South African context.

Figure 4.4: Schematic illustration of the model for the relationships between constructs that contribute to positive e-waste behaviour intentions



4.7 THE DETERMINANTS OF E-WASTE RECYCLING BEHAVIOUR INTENTIONS BASED ON THE THEORY OF PLANNED BEHAVIOUR (HYPOTHESIS 1-5)

4.7.1 Attitude towards the behaviour

- ***Hypothesis 1: Environmental awareness and e-waste recycling behaviour intentions***

A positive connection between environmental awareness and behavioural intentions has been established in developed and developing markets. Saphores *et al.* (2006:201) asserted that California (Mono County) has a long history of environmental awareness and found they are willing to recycle all types of waste. This type of urban community has a high level of traditional household garbage pick-up, which is not the case in rural areas. Willingness to recycle even increases if collection points are more than 5 miles or conventional recyclable curb-side collection does not exist. The inference is made that

consumers have to take re-cyclables to collection sites, and e-waste drop off is therefore not a huge inconvenience. Nixon and Saphores (2007:557) focused on US households' decision to recycle. Tonglet, Phillips and Read (2004:211) looked into the determinants of recycling behaviour in Brixworth, UK. Both these studies suggest consumer environmental awareness does influence their recycling behaviour intentions.

Other studies focused on the different levels of consumer environmental awareness of e-waste disposal in developing markets. Afroz *et al.* (2013:185) examined the situation in Malaysia, and found most of the respondents (59%) were aware of the impacts of WEEE on the environment and did (65%) consider environmental factors when purchasing domestic EEE. However, disappointingly only 2% to 3% were actively involved in e-waste recycling. Borthakur and Govind (2018:1065) reported very low levels of public understanding of E-waste and its disposal in urban Bangalore, India. Alarmingly they found that 90% of the respondents surveyed had no knowledge about e-waste. Chaudhary and Bisai (2018:804) reported that environmental awareness does significantly influence attitude toward green buying behaviour intentions of millennials in India. Wang, Guo and Wang (2016:855) revealed that concern for the environmental has a positive effect on their recycling behaviour towards e-waste recycling in Beijing City, China. Lizin *et al.* (2017:76) also found awareness of e-waste consequences to be a significant factor in explaining battery pack recycling intentions in Belgium.

Accordingly, the following research hypothesis can be proposed:

H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.

- ***Hypothesis 2: Attitude towards e-waste recycling and e-waste recycling behaviour intentions***

In the context of green marketing, a positive connection between attitude and behavioural intention has been established by different scholars. In a sustainable tourism context, Han *et al.* (2010:325) revealed that attitude positively affected intention to stay at a green hotel. Similar findings were reported in studies regarding the attitude and intention of consumers towards green product behaviours (Chaudhary & Bisai, 2018:798; Paul *et al.*, 2016:123).

This relationship was also verified for recycling behaviours in developed and developing countries. Nixon and Saphores (2007) and Tonglet *et al.* (2004) supposed that attitude

toward e-waste recycling effectually encouraged recycling behavioural intention of UK and USA consumers. This is in line with the study by Hansmann *et al.* (2006), who reported that the attitude toward households' recycling in Switzerland had a significant positive effect on their battery recycling behaviour intentions.

Similarly, findings were reported in developing markets. Echegaray and Hansstein, (2017:180) revealed that attitude positively affected the recycling of electronic appliances in Brazil. Nguyen *et al.* (2018:1) examined e-waste recycling behavioural intentions regarding six kinds of common e-waste (refrigerators, air conditioners, washing machines, computers-PCs, TV sets, and mobile phones) in Vietnam. The findings showed that the correlations between attitude towards e-waste recycling and recycling behaviour intentions were statistically meaningful.

Based on these findings, the following research hypothesis can be concluded:

H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.

4.7.2 Norms

- ***Hypothesis 3: Norms and the behaviour intention to e-waste recycling***

Conflicting research results have been reported regarding the influence of Norms (in the form of laws, regulations and relevant information published in the media) on green marketing behaviour intention.

Some findings support a positive relation between norms and e-waste recycling behaviour intention. Some studies suggest that laws and regulations ruled by the Government must play a vital part in e-waste recycling. The recent study by Lizin *et al.* (2017:76) reported norms to be a significant factor in explaining battery pack recycling intention in Belgium (Lizin *et al.*, 2017:76). Chaudhary and Bisa (2018:798) reported that norms exert a significant influence on green product consumptions behaviour and intentions of millennials in India. This was once again confirmed in the recent study by Borthakur and Govind (2018: 1065), who reported that norms have a positive influence on e-waste disposal intention and overall environmental sustainability in the city of Bangalore, India.

Nguyen *et al.* (2018) indicated that laws and regulations played the most significant role in residents' e-waste recycling intentions in the socialist country of Vietnam. Nixon and Saphores (2007:20) also confirmed that public information campaigns could increase awareness of applicable conservational laws and of negative consequences of inappropriate e-waste disposal. This in turn could gain the support for paying an ARF for electronics.

Paul *et al.* (2016) failed to find any significant association between norms and green product consumption intentions. Zhong and Huang (2016:478) established that ambiguous laws and regulations have a considerable negative impact on consumers' willingness to be part of formal e-waste recycling in China. They concluded that the central and local Chinese government were to be blamed for the lack of spreading information on suitable practices for household e-waste collection. The lack of suitable information also seems to be evident in the USA. Milovantseva and Saphores (2013:14) found that although an e-waste ban exists, this had no statistical significance on the intention to recycle TVs versus trashing or re-using them.

The only effect was that consumers opted to store TVs at home, which suggests that e-waste disposal bans are poorly enforced and/or poorly publicised.

Based on the information from this discussion, the following research hypothesis can be concluded:

H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.

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4.7.3 Perceived Behavioural Control

- ***Hypothesis 4: Recycling costs and e-waste recycling behaviour intentions***

It is supposed that the more expensive the expenditure on e-waste recycling is, the less likely residents are inclined towards recycling e-waste. A national survey of U.S. households found that recycling cost was not statistically significant related to e-waste recycling intentions (Saphores *et al.*, 2012); this seems to be one of the exceptions. Several other studies revealed a link between recycling costs and e-waste recycling behaviour intentions. Wang *et al.* (2016:855) examined the e-waste recycling behaviour

intentions of Chinese residents from seven geographic regions and 22 provinces. The study found that the perceived costs of recycling had a negative influence on the recycling behaviour towards e-waste in China. The implication was that recycling efforts are reduced if residents experience or perceive the cost of recycling to be high. This is similar to the Indian study by Saritha, Sunil Kumar and Srikanth (2015:36), which revealed the cost associated with e-waste recycling (such as traveling to recycling centres and recycling fees) was a hurdle for getting involved in recycling for households in Visakhapatnam.

The income loss due to replacement of old appliances was also considered as part of recycling costs. Colesca, Ciocoiu and Popescu (2014:363) revealed that large appliances were typically used for 13 to 17 years in Romania, as opposed to the European standard of 8 to 10 years. In Romania, as in other developing countries, low-income consumers make use of the take-back as a recycling method as they receive a discount when purchasing new equipment. Borthakur and Govind (2018:1065) revealed that a large portion of households in Bangalore, India (32.6%) give their unused electronics to their children/relatives.

Wang *et al.* (2017:301) identified the practice of consumers to sell their e-waste to informal peddlers due to the convenience and the payment received as a barrier to collection of household equipment in Beijing City, China. The implications were that formal collectors thus have difficulty to collect and recycle e-waste in an environmentally friendly way. Around the world, especially in developing countries, money is a contentious issue. Consumers typically do not want to spend money to recycle and would prefer to receive money in exchange when disposing of e-waste.

Therefore, the following hypothesis is formulated for this study:

H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.

- ***Hypothesis 5: Recycling convenience and e-waste recycling behaviour intentions***

It is believed that the less convenient e-waste recycling is, the higher the likelihood of e-waste recycling behaviour intentions, however Wang *et al.* (2016:855) could not verify

this supposition in a research study in Beijing City, China. The main mode of recycling for the majority of residents was selling to small-scale e-waste dealers. Residents received higher monetary returns using this method and it was more convenient for them. In another study in China, it was confirmed that the adverse recycling conditions for consumers was an obstacle for participation in formal e-waste recycling (Zhong & Huang, 2016:478).

Several studies conducted in developed and developing markets reported on the link between recycling convenience and positive e-waste recycling behaviour. The study by Saritha, Sunil Kumar and Srikanth (2015:36) in Visakhapatnam, one of the fastest growing cities in India, indicated the lack of convenience and security at recycling centres as a major hurdle for recycling. Colesca *et al.* (2014:363) reported that Romanian consumers have a positive attitude towards recycling, however inconveniences, such as the time to dispose items and the distances to recycling facilities, were major inhibitors preventing e-waste recycling behaviour.

A highly inconvenient recycling infrastructure in the Brazilian environment was found to be the main factor that demotivated upmarket residents from being involved in recycling practices (Echegaray & Hansstein, 2017:186). Bendak and Attili (2017:7) indicated inconveniences such as long distance to recycling bins and a shortage of recycling bins as factors that played a negative role in recycling habits in the United Arab Emirates (UAE).

Ylä-mella, Keiski and Pongrácz (2015:374) found the proximity and convenience of the waste collection systems in Finland to be inadequate and hampering the return of small e-waste; this also had an effect on the re-use and recovery possibilities. Favot and Grasseti (2017:229) indicated that the presence and accessibility of collections points in Italy had a positive effect on e-waste collection. Saphores *et al.* (2006:200) confirmed in a USA (California) study that recycling convenience is crucial to get consumers to consider e-waste recycling. These studies in developed countries illustrated that convenient facilities, and convenient placement of these collection facilities, positively contributed to e-waste recycling efforts. South Africa has a poor collection infrastructure therefore the following hypothesis is formulated for the South African study:

H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.

4.8 REWARDS AND PENALTIES TO PROMOTE E-WASTE RECYCLING BEHAVIOUR (HYPOTHESIS 6-7)

Steg and Vlek (2009) conducted an extensive and critical review of studies to guide, assess and promote pro-environmental behaviour. They distinguished between antecedent informational strategies aimed at changing factors that precede pro-environmental behaviour (e.g. information and education) and consequence strategies (e.g. feedback, rewards and penalties) aimed at either rewarding "good" behaviour or punishing "bad" behaviour. They advised it was crucial to examine what types of behaviour and under what conditions, which rewards and punishments strategies were most effective for encouraging pro-environmental behaviour. This study therefore examined how a PRS (Hypothesis 6) and payment of an ARF (Hypothesis 7) would influence South African consumers' e-waste recycling behaviour intention.

4.8.1 PRS to reward e-waste recycling behaviour

- ***Hypothesis 6: Willingness to participate in a PRS and e-waste recycling behaviour intention***

Scholars found that rewards (e.g. financial rewards) were more helpful in promoting pro-environmental behaviour than penalties (e.g. taxing and levies), because incentives were linked to positive attitudes that support positive intentions or actions (Geller, 2002:94). A few recent studies also considered the effect of consequence strategies on pro-environmental behaviour in terms of e-waste. Borthakur and Govind (2018:1065) assert that financial incentives are a vital consideration for Indian consumers. Some of them therefore sell their e-waste to the scrap dealers or 'kawariwalas' at certain cost. A very small portion of the vast volume of e-waste produced in China is recycled in an environment-friendly way and e-waste recycling consumer participation levels are very low. Zhong and Huang (2016:477) therefore tested whether a PRS could help to alleviate some challenges in China's electronic waste recycling management system. The study focused specifically on residents of an urban city in China, and results showed that the vast majority of consumers were willing to participate in e-waste recycling motivated by a

PRS. This implies that using PRS to achieve recycling was highly acceptable to these Chinese consumers and increased their willingness to participate in e-waste recycling. It can thus be assumed that South African households would also react positively to being involved in PRS. Therefore, the following hypothesis is formulated for the current South African study:

H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.

4.8.2 Advanced recycling fee (ARF) to finance e-waste recycling behaviour

- ***Hypothesis 7: The willingness to pay an ARF and e-waste recycling behaviour intention***

Conflicting research results have been reported regarding consumers' willingness to pay for e-waste recycling and the amount they are willing to pay.

Some suggested that consumers were generally willing to pay (Nixon & Saphores, 2007:557; Saritha, Sunil Kumar & Srikanth, 2015:38; Song, Wang & Li, 2012:14), while others reported they were unwilling to pay these ARF (Afroz *et al.*, 2013:1; Islam, *et al.*, 2016:737; Yin, Gao & Xu, 2014:517).

Afroz *et al.* (2013:12) revealed that only half (52.5%) of the households in Kuala Lumpur were prepared to pay for improving WEEE management system. They would rather sell their old equipment to scrap collectors than giving compensation to a third party to collect the waste. Islam *et al.* (2016:737) found that only 5% to 10% of Bangladeshi households were willing to pay to recycle e-waste. This unwillingness to pay was because most of them (53.72%) preferred to get economic benefits by selling their WEEE items. Yin, Gao and Xu, (2014:517) indicated that less than half of Chinese consumers (47.9%) were willing to pay an ARF to recycle mobile phones, with the acceptable ARF being between 0-5% of the original purchase price.

Nixon and Saphores (2007:557) reported that most US households were willing to pay a 1% ARF. They concluded that older and middle-aged consumers should first be targeted to improve e-waste recycling programmes. Song, Wang and Li (2012:14) examined the payment of an ARF as a potential solution to the growing e-waste volumes in municipal

solid waste of Macau, China. The findings indicated that a large portion of residents were willing to pay reasonable amount for recycling solid waste. This willingness increased with education level. However, those unwilling to pay believed this type of recycling remains the responsibility of the Government and should be collected at no charge. They believed they could get money for selling e-waste rather than paying an ARF. Saritha, Sunil Kumar and Srikanth (2015:38) reported that the majority of Indian consumers from Visakhapatnam (78.8%) were willing to pay an ARF included in the purchase price of the product. The acceptable ARF differs, as some respondents (24%) were willing to pay 1 to 5% of the product cost, while 41.6% of respondents were willing to pay 5 to 10% of the product cost, and 18.4% would be willing to pay more than 10% of the product cost.

Although consumers of e-waste around the world (developing countries) were willing to pay a recycling fee, literature shows they were only willing to pay a low percentage of the selling price, and would prefer to get some money back at the time of disposal.

As a developing country, the following hypothesis is formulated for the South African study:

H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.

4.9 DEMOGRAPHICAL VARIABLES AND E-WASTE RECYCLING BEHAVIOUR INTENTIONS (HYPOTHESIS 8-9 A, B, C)

Conflicting research results have been reported regarding the influence of income and demographical variables on-waste recycling behaviour intentions across the globe. These results are reviewed in the following sub-sections.

4.9.1 Income

- ***Hypothesis 8: Income and e-waste recycling behaviour intention***

Milovantseva and Saphores, (2013:15) indicated that higher income earners (\$100,000/household) preferred to recycle TVs instead of storing them or having them repaired compared to annual household incomes between \$50,000 and \$100,000. This is in line with Nguyen *et al.*, (2018:3), who proved that e-waste recycling in Vietnam was

better for consumers with a higher income, compared to those in the medium and lower income categories.

Wang *et al.* (2016:855-856) found income negatively influences e-waste recycling behaviour intentions in Beijing City, China. This implies that higher earning consumers are less inclined to recycle compared to lower income groups. Higher income consumers typically do not care about the recycling benefits and prefer to avoid inconvenience and problems associated with recycling e-waste. It was also established that age, gender and educational background did not show a significant effect on the behaviour intention towards e-waste recycling. This is similar to the findings of studies in developing countries. Echegaray and Hansstein (2017:185) revealed that income negatively correlates with the e-waste recycling behaviour intention in Brazil.

Based on these findings the following hypothesis was postulated:

H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.

4.9.2 Demographical variables

- **Gender**

Findings from previous studies have yielded incompatible results regarding gender. Borthakur and Govind (2018:1056) found that gender has no significant influence on e-waste understanding and recycling behaviour in urban Bangalore, India. Bendak and Attili (2016:6) also found that the effect sizes of differences between males and females in the UAE were negligible in real-life terms.

Zhong and Huang (2016:479) discovered that females and consumers in the 30 to 49 years age group were more inclined to recycle e-waste compared to males and other age groups in China. This is in line with the study by Favot and Grassetti (2017:229), which indicated females in Italy were more willing to recycle e-waste compared to males. The study by Saphores *et al.* (2006:201) conducted in California, USA, also showed that women were much more willing to recycle e-waste compared to males with otherwise similar characteristics. This is contrast to another USA study conducted by Milovantseva

and Saphores, (2013:15), where females were found to be more likely to store old TVs rather than recycling them, which could show a lack of confidence in e-waste recycling.

- **Age**

There is little consensus on the effect of age and e-waste recycling behaviour intention. Bendak and Attili (2016:6) found that the effect sizes of difference in terms of age groups in the UAE were negligible in real-life terms. Hence, age does play a significant role in this context. Conversely, Zhong and Huang (2016:479) found that age did play a significant role in China. Younger consumers reported significantly higher e-waste recycling willingness than older consumers. Echegaray and Hansstein (2017:4) also put forward that younger cohorts in Brazil were more inclined to embrace recycling.

However, this is in contrast with several other studies that indicated a negative relation between age and e-waste recycling willingness. Colesca, Ciocoiu and Popescu (2014:361-362) revealed that an increase in age showed a noticeable decline in the positive attitude towards e-waste recycling in Romania. The results by Nixon and Saphores (2007) concluded that middle-aged and older adults in Californian households were more willing make some effort towards recycling of electronics.

Borthakur and Govind (2018:1065) concurred that older consumers were more likely to participate in e-waste recycling behaviour than the urban youths in the city of Bangalore. They concluded there is an increasing probability of e-waste generation in the near future.

- **Education level**

Bendak and Attili (2016:6) reported that the effect sizes for the difference in terms of education levels in the UAE were negligible. Colesca, Ciocoiu and Popescu (2014:361) revealed that e-waste recycling is correlated with education. Echegaray and Hansstein (2017:4) put forward that better educated consumers in Brazil were more inclined to embrace recycling. Nguyen *et al.* (2018: 3) proved that education level has the largest impact on consumers' willingness to recycle e-waste in Vietnam.

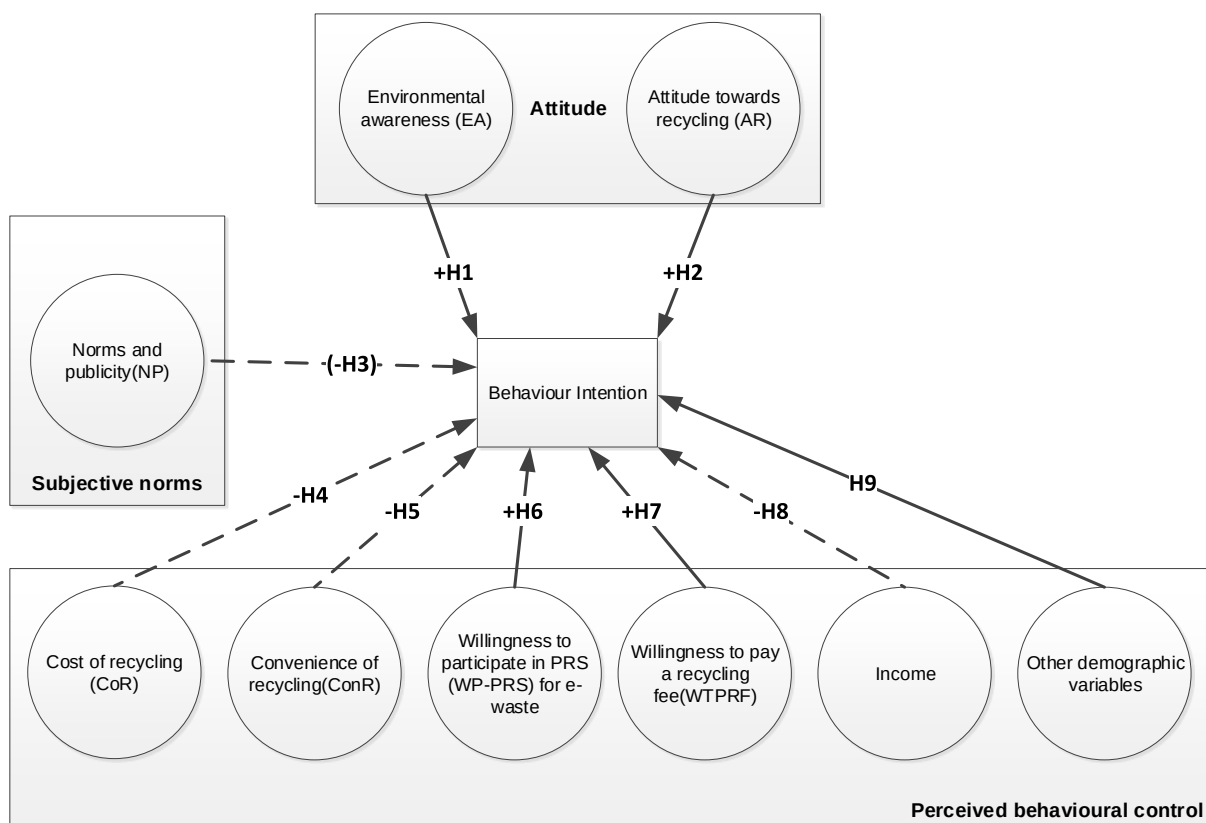
Based on these findings the following hypothesis was postulated:

H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

4.10 PROPOSED MODEL FOR THIS SOUTH AFRICAN E-WASTE STUDY

Figure 4.5 shows the proposed model for the quantitative phase of the study, which will be conducted about South African urban household consumers' e-waste recycling behaviour intentions, based on TPB. The nine hypotheses, together with the positive or negative contributions towards e-waste behaviour intention, are indicated in Figure 4.5.

Figure 4.5: Conceptual framework for the South African e-waste scenario



4.11 CONCLUSION

In this chapter the different aspects of consumer's e-waste behaviour were presented. Green growth, green economy and green marketing were reviewed. An explanation of the widely used TPB model, as well as evidence of the use of the model in the e-waste research environment were examined. This was followed by the literature used for the hypothesis's development and the proposed model for this South African e-waste study. In the chapter to follow, the research design and methodology will be discussed.

CHAPTER 5 - RESEARCH DESIGN AND METHODS

5.1 INTRODUCTION

In Chapters 2 and 3, a literature review was done on current and past practices of e-waste management around the globe. In Chapter 2, some e-waste management principles were discussed on current WEEE practices and to highlight the essential elements contributing to effective e-waste recycling around the world as derived from available relevant literature. Chapter 3 presented the practices, and lack thereof, as applied to the South African environment and it concluded with a conceptual framework used as a guide for the qualitative research phase of the current study. In Chapter 4 the use of the TPB model was discussed as applied on e-waste consumers. A conceptual framework, based on the TPB model, was proposed and used to conduct quantitative research amongst South African consumers. The current study followed a mixed methods approach. In this chapter, the qualitative and quantitative research components will be discussed, as well as the methods and procedures followed to conduct the study. The quality issues of both the qualitative and quantitative research will be addressed, as well as the measures that had to be taken to ensure the ethical considerations.

Table 5.1 shows the research process that will be followed in this mixed method study to propose a framework for the re-use, recycling and disposal of waste electrical and electronic equipment, the South African case. The considerations outlined in this process will be discussed in detail throughout the rest of the chapter.

Table 5.1: The research process followed in the mixed method study

MIXED METHODS RESEARCH: Convergent parallel design	
THE QUALITATIVE RESEARCH PHASE	THE QUANTITATIVE RESEARCH PHASE
QUALITATIVE OBJECTIVE: To explore the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.	QUANTITATIVE OBJECTIVE: To examine the drivers and inhibitors of e-waste recycling behaviour intentions of South African household e-waste consumers.
THE RESEARCH ORIENTATION & PARADIGM - Paradigm: Interpretivist	THE RESEARCH ORIENTATION & PARADIGM - Paradigm: Positivist
RESEARCH DESIGN: Content analyses	RESEARCH DESIGN: Descriptive cross-sectional research design
SAMPLING - Selection of participants: purposive sampling & snowball sampling. - Participant selection criteria: experienced individuals in e-waste related managerial positions. - Target groups & Sample sizes. - Total of 20 participants in four Stake-holder groups: - Environmental specialists (ES) - Government authorities (GA) - Recycling/disposal entities (RDE) - Supply Chain members (SCM)	SAMPLING - The target population: adults residing in urban areas of South Africa. - Sampling frame: Not used. - Sampling technique: Non-probability convenience sampling. - Sample size: 522 online surveys.
DATA COLLECTION - Data collection method: semi-structured interviews. - Measurement instrument: Interview guide.	DATA COLLECTION - Data collection method: online surveys. - Measurement instrument: Structured questionnaire measuring nine constructs and demographical information.
DATA ANALYSIS AND REPORTING - Software package: Atlas.ti - Qualitative content analysis procedure: - Arranging the data - Familiarisation with the data - Code & category development - Generating themes - Interpretation and reporting the findings	DATA ANALYSIS AND REPORTING - Preparing and processing data: SPSS. - Analysis of the data: Descriptive & inferential statistics. - Parametric technique: T-tests, Analysis of variance (ANOVA). - Non-parametric: Spearman's rank order correlation with Oblimin rotation & Chi-square for goodness of fit. - Factor analysis: Principal Component Analysis (PCA) & Kaiser-Meyer-Olkin (KMO) measure. - Measurement Model; Structural Equation Modelling (SEM).
EVALUATING THE QUALITY - Credibility/internal validity - Dependability/consistency - Transferability/external validity - Authenticity/construct validity	RELIABILITY AND VALIDITY - Reliability: Cronbach alpha - Validity: - Face validity, Content validity, Construct validity
RESEARCH ETHICS	RESEARCH ETHICS
INTEGRATION PHASE: Integration objective: To advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) should be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South-Africa (qualitative results). Integration strategy: To compare the data sets in order to determine which measures could be suggested for implementation (from the qualitative phase) to address personal convenience, attitude towards e-waste recycling, and environmental awareness of consumers towards disposal of e-waste (the quantitative phase)	

5.2 RESEARCH PROBLEM, AIM AND OBJECTIVES

5.2.1 Research problem

Several studies on the WEEE management systems and practices in industrialising countries have been conducted in reaction to the increasing quantities of e-waste, (Bahers & Kim, 2018; Dias, Bernardes & Huda, 2018; Duygan & Meylan, 2015; Morris & Metternicht, 2016; Parajuly, Habib & Liu, 2017; Ylä-Mella *et al.*, 2014; Zacho, Bundgaard & Mosgaard, 2018). Some recent studies compared the WEEE management in different countries (Garlapati, 2016; Khan *et al.*, 2014; Lepawsky, 2012; Nnorom & Osibanjo, 2008; Oliveira, Bernardes & Gerbase, 2012; Ongondo, Williams & Cherrett, 2011; Salhofer *et al.*, 2016; Sthiannopkao & Wong, 2013; Torretta *et al.*, 2013; Zeng *et al.*, 2013), however only a few studies on WEEE management systems and practices in developing countries have been conducted (Ciocoiu, Burcea & Tartiu, 2010; Dias *et al.*, 2018, Manomaivibool & Hong, 2014; Rousis *et al.*, 2008; Yang, Lu & Xu, 2008) and none in South Africa.

Furthermore, some quantitative surveys have been conducted to investigate the determinants of consumers' e-waste recycling and disposal behaviour. These studies predominantly focused on developed markets (Hansmann *et al.*, 2006; Lizin *et al.*, 2017; Nixon & Saphores, 2007; Saphores *et al.*, 2012; Tonglet *et al.*, 2004; Ylä-Mella, Keiski & Pongrácz, 2015). Recently, consumers in developing markets, such as Brazil (Echegaray & Hansstein, 2017), Vietnam (Nguyen *et al.*, 2018) and China (Wang *et al.*, 2016; Zhang *et al.*, 2016; Zhong & Huang, 2016) have also been surveyed on their e-waste recycling and disposal practices. None of these researchers surveyed South African household e-waste consumers to identify drivers and inhibitors of e-waste recycling behaviour in this context.

Scholars in this field typically followed either a qualitative or quantitative research approach. An integrated summary of the determinants and inhibitors of the consumers' e-waste behaviour (quantitative research), and stakeholders' views (qualitative research) and WEEE management by stakeholders does not currently exist.

5.2.2 Research aim and objectives

The aim of this study is:

To propose a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

Creswell (2015a:20) recommends the separate development of research objectives and research questions/hypotheses for the qualitative, quantitative, and mixed methods phases of a mixed methods study. Separate questions help to identify the intent of the qualitative inquiry, the quantitative inquiry, and the integrative component (Guetterman, 2017:14). In order to meet the aim of this study, three *research* objectives were crafted. The three research objectives with accompanying research questions for the qualitative phase and hypotheses for quantitative phase and integration phase are indicated below.

- **Qualitative phase**

Research objective 1:

To explore the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

Research questions:

- RQ1a: What are the current practices and views of key stakeholders involved in the lifecycle of electrical and electronic equipment on e-waste collection from household consumers?
- RQ1b: What are the current practices and views of key stakeholders involved in the lifecycle of electrical and electronic equipment on e-waste distribution to recyclers?
- RQ1c: What are the views of key stakeholders involved in the lifecycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

- **Quantitative phase**

Research objective 2:

To examine the drivers and inhibitors of e-waste recycling behaviour intentions of South African household e-waste consumers.

Hypotheses:

- H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.
- H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.
- H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.
- H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.
- H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.
- H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.
- H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.
- H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.
- H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

- **Integration phase:**

Research objective 3:

To advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) should be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South-Africa (qualitative results).

5.3 MIXED METHODS RESEARCH

5.3.1 Rationale for using mixed methods

Creswell and Plano Clark (2007:5) describe mixed methods research as a design guided by specific philosophical assumptions and methods of enquiry. From a methodology viewpoint, the philosophical assumptions are guiding the route of data collecting and

analysis as well as the mixture of the quantitative and qualitative approaches in different phases of the research study.

From the methods viewpoint, the focus is on the collection, analyses, and the mixing of qualitative and quantitative data using a series of studies or a single study. The core principle is that the combined use of qualitative and quantitative tactics will give a superior understanding of the problem being researched, compared to using any of the two approaches on its own.

The value of applying mixed methods can be classified in the following reasons (Collins, Onwuegbuzie & Sutton, 2006:83; Guetterman, 2017:3): 1). Participant improvement of soliciting participants and guaranteeing proper sampling; 2). Developing instrument or/and testing their validity; 3). Understanding treatment or programme dependability issues; 4). Enhancement and substantiation of the findings.

In the current study, mixed methods were applied to build comprehensive understanding of the complex and nuanced phenomenon of WEEE waste from the perspective of key stakeholders and consumers. Gaining a comprehensive understanding of magnitude and nature of WEEE waste handling could not be assessed with existing quantitative instruments or qualitative techniques alone. The qualitative phase of this study led to appreciation of the actual practices and views of key stakeholders in South African industry. The quantitative research phase helped to examine the relationship between the drivers and inhibitors of e-waste recycling behaviour intentions of e-waste consumers.

5.3.2 Convergent parallel design

According to Creswell and Plano Clark (2011:68), a mixed methods researcher must carefully select a design that reflects the level of interaction between research strands, the relative priority of the strands, timing arrangements, and the mixing of the results of the strands. A mixed method design differs on these points, and has to be selected to solve the research problem correctly and have a reason for mixing. It should thus ensure a manageable study, which can be implemented and described appropriately.

The current study applied a convergent parallel design, also known as the convergent design or concurrent design (Creswell, 2015:36-37). Figure 5.1 illustrates how the

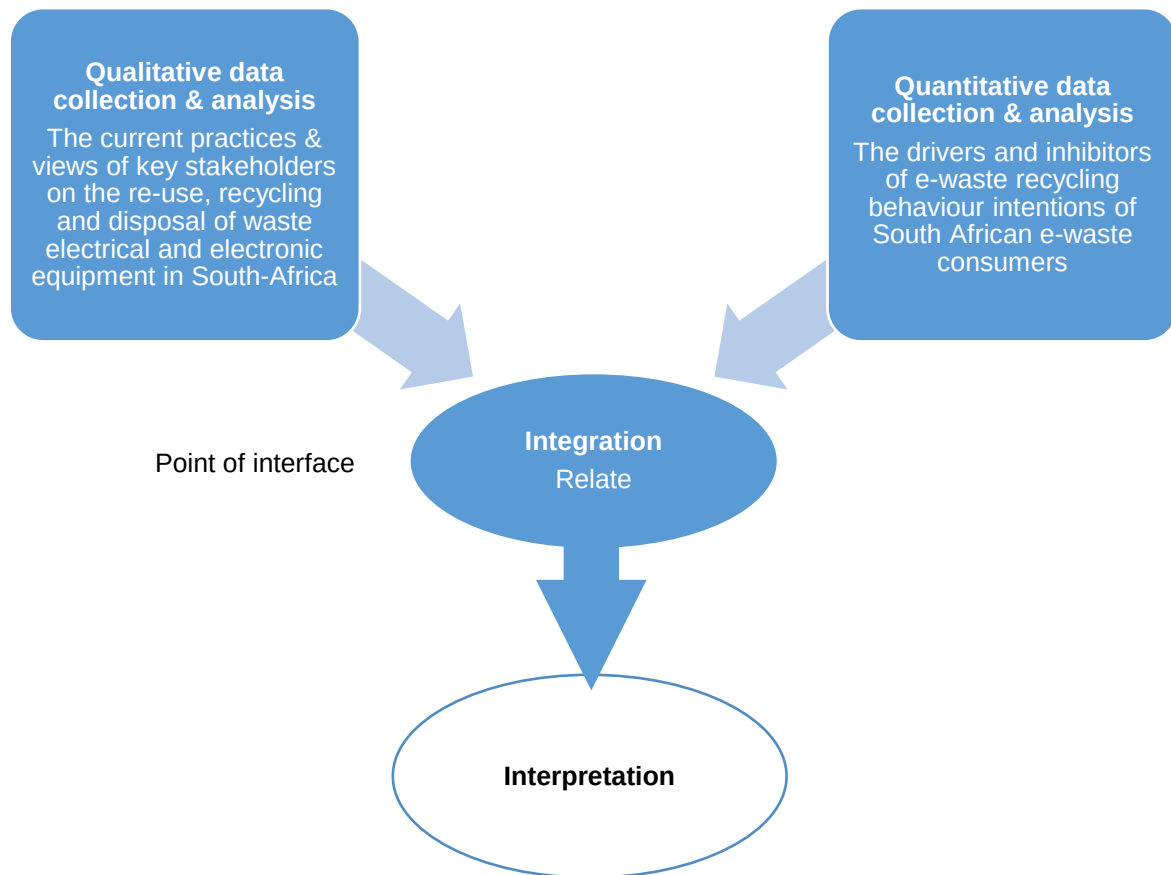
convergent design was applied to understand the reuse, recycling and disposal of waste electrical and electronic equipment in South Africa.

The quantitative and qualitative phases were done simultaneously during the research process, the methods were prioritised equally, and the analysis of the two phases were done independently. The results of the two strands were then mixed for overall interpretation, as suggested by Guetterman (2017:5).

The researcher used the convergent parallel design to obtain qualitative results from 20 participants from different stakeholder groups (environmental specialists, government authorities, recycling/disposal entities and supply chain members) regarding the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. The qualitative research questions (RQ1a, RQ1b and RQ1c) required an in-depth understanding of the highly complex and diverse areas associated with the management of urban household e-waste. A qualitative phase was deemed necessary to ensure that rich and insightful experiences, preferences and suggestions could be extracted from these stakeholders.

The quantitative phase of the study involved a survey with a sample of 522 South African consumers of urban household e-waste on the drivers and inhibitors of e-waste recycling behaviour intentions. To test the specific hypotheses (H1-H9), quantitative data was required. Integration of both quantitative and qualitative data in the current study provided a better understanding of the research problem than either approach alone.

Figure 5.1: The convergent parallel design



Source: Adapted from Creswell and Plano Clark (2011:69)

5.4 THE QUALITATIVE RESEARCH PHASE

Individuals interact with the world they live in, and meaning is thus socially formed. This is the key to understand qualitative research (Merriam & Associates, 2002:3). In qualitative research, people's experiences can be explored in detail using research methods such as focus groups, interviews and observations. The study participant allows the researcher to understand issues from their perspective, making this an interpretive approach (Hennink, Hutter & Bailey 2011:9).

An important characteristic of qualitative research is that it is an inductive process, where the data collected build towards theory. Document quotes, interviews, files and notes contribute towards a richly descriptive nature associated with qualitative research (Merriam & Associates, 2002:5).

Qualitative interpretation of data requires the researcher to go beyond the descriptive data. It requires the attaching of significance to and making sense of what was found, give explanations, drawing conclusions, making of inferences, extrapolation of data, interpret meanings, and making sense of a disorderly world that still has structure (Patton, 2015:570).

The interpretations of reality are numerous and diverse, and they change with time. Qualitative researchers are concerned about the interpretations in context and at a specific point in time. An interpretive qualitative approach is considered as one where the researcher gains knowledge around the experience and interactions of individuals about the meaning and the interaction they have with their social world (Merriam & Associates, 2002:4).

A qualitative enquiry was applied to address research objective 1 and three related research questions. This helped gain an in-depth understanding of the views of knowledgeable experts regarding e-waste collection, transport arrangements and procedures that are needed to manage the process to effectively deal with e-waste from urban households. In this type of exploration, data needs to be collected, analysed, classified, and categorised to make sense of the phenomenon under investigation, i.e. urban e-waste management. A qualitative research approach was used in this study to explore the views of stakeholders on how an urban household e-waste management system should function, and what systems need to be in place to ensure functionality. The result was rich accounts and perceptive information from knowledgeable stakeholders over a wide spectrum in the South African household e-waste scenario.

The objective of the qualitative phase was to explore and understand how e-waste specialists in different stakeholder groups view the overall household e-waste management process and systems needed to accomplish it. The researcher was able to explore their understanding of key concepts through verbally communicating and interacting with the participants in the study. The information collected could immediately be explained by participants and further explored when unexpected and vague responses were received. In-depth analysis followed using data gained through these interviews.

Having studied the literature, the researcher formulated new untested concepts that needed to be presented to specialists in the field for feedback. Questions were presented to participants, which would also enable the answering of the original research questions. This approach enabled the researcher to receive feedback on the possible implementation, or rejection, of the concepts as well as collecting insights and proposals addressing the research questions.

In qualitative research, the researcher is the primary research instrument doing the collection and analysis of the data (Merriam & Associates, 2002:5). For the current study, the researcher gained knowledge and understanding of the research field by studying the relevant literature and by personal experience of the operation of the South African e-waste recycling scenario. This included informal discussions with key stakeholders, observations of e-waste practices, and reviewing relevant e-waste studies. The initial stakeholders included consumers who have e-waste that must be disposed of, recyclers, environmentalists, refurbishers, and individuals in government structures. This directed the researcher to focus on current practices of household e-waste management locally and abroad. This process was followed by the researcher, getting first-hand experience of the depth of the problem.

5.5 THE RESEARCH ORIENTATION AND PARADIGM OF THE QUALITATIVE RESEARCH PHASE

There are three major research paradigms, each with its own philosophical underpinning, namely: positivism, interpretivism, and critical theory. Any phenomena can be investigated under one of these paradigms. The philosophical outlook chosen by a researcher must be steered by the needs and requirements of the research study (Rehman & Alharthi, 2016:51).

For the qualitative phase of this study, the interpretivist paradigm was applied. Qualitative research is seen as the “process theory,” where the world is seen in terms of processes connecting people, events, and situations (Maxwell, 2013:29). A qualitative research paradigm refers to the generic research approach a researcher takes to gain the insider’s perspective (the “emic”).

The goal is to describe and understand (*verstehen*), and not predict or explain human behaviour on a phenomenon being studied (Babbie & Mouton, 2001:53). The qualitative interpretivist research paradigm outright rejects the concept of a single verifiable reality, which exists, irrespective of our senses. Interpretivists believe in multiple realities, which are socially created; the view is that our senses are always mediated, making it impossible to know reality as it is.

The goal of this qualitative phase of the research has been to understand and describe the experiences, views and preferences from selected individuals who have expert knowledge and experiences in the e-waste environment. The perceptions and preferences of these individuals were elicited to determine which measures were needed and appropriate in South Africa to start and maintain a management process for e-waste. The aim was not theory testing, generalising results or predicating phenomena, this research was undertaken because e-waste management for South Africa needs to address a co-ordinated system of collection, transportation, recycling, and disposal of e-waste. Furthermore, a need exists to propose suitable measures to manage and finance the entire process.

Rehman and Alharthi (2016:55-56) assert that each paradigm is associated with a unique a) ontology, b) epistemology, c) methodology, and d) methods. *Ontology* refers to the “form and nature of reality” and asks the question “What is there that can be known about it.” In an assumed “real” world, how do things really work, and how are things really? The ontology of the interpretivistic paradigm is anti-foundationalist, while the epistemology is subjective. For the qualitative phase of this study, it was necessary to determine how participants experience the e-waste environment, get a sense of how e-waste is currently managed, and get the perceptions from experts on how they perceive the way forward.

Epistemology refers to a theory of knowledge, and social research is normally done using the dominant “ways of doing things” as a background. Epistemology needs to understand how rules are determined, what constitutes ‘knowledge,’ and which ‘knowledge’ is valued over other (Walter, 2006:15). For the qualitative phase of this study, careful consideration must be given when interviews are conducted. Participants have different experience frameworks, e.g. some could be having rural backgrounds while others are from first world countries.

Among the environmentalists the participants had South African urban backgrounds while one participant immigrated to South Africa from Germany. In the Government sector the participants had rural and urban upbringings which could shed light on different environments. The recycling/disposal entities had a mix of urban South African citizens and one with an Italian background. Finally, the supply chain members had South African urban experiences as well as international ties with The Netherlands and America. The knowledge base of the participants, and the way things are done differ and should be taken into consideration by the researcher, especially during interviews.

Methodology refers to the approach the investigator (would-be knower) would follow to determine “whatever he or she believes can be known” (Guba & Lincoln, 1994:108). Methodology associated with the interpretivist paradigm helps to explore the challenges and complexities of the enormously complicated social world we live in (Richards, 2003:6). For the qualitative phase of this study, qualitative content analysis was applied as research design and methodology.

Method refers to the explicit way in which data is collected and analysed. This could be through surveys or open-ended interviews. The theoretical mind set of the researcher and the design of the project will determine the methods most appropriate (Rehman & Alharthi, 2016:52). For the qualitative phase of this study, participants representing key stakeholders in the WEE industry were chosen based on purposive sampling and snowball sampling. In-depth interviews were used to collect data, while an interview guide was used as a measuring instrument.

5.6 RESEARCH DESIGN OF THE QUALITATIVE RESEARCH PHASE

5.6.1 Research designs

A research design refers to the plan or blueprint to conduct a research study. In the research design the focus must be 1) on the end product, i.e. what are the results and what kind of study is planned, 2) the point of departure, thus the research question/s, and 3) what type of research evidence is needed to adequately address the research question/s (Babbie & Mouton, 2001:74). Creswell (2013:49-50) summarises the design into three components: 1) preliminary considerations, 2) steps in the process, and 3)

elements in all phases of the research. *Preliminary considerations* include the researcher's background, politics and existing theory. The *steps in the process* involves a literature study, formulation of research question/s, deciding on the best sources of information, collecting data, analysing data, and discussing the findings. *Elements in all phases of the research* refers to ethical considerations and reciprocity-giving back to participants (Creswell, 2013:50-55). A research design thus guides the process of how data must be collected, to how it must be analysed during the study.

5.6.2 Qualitative content analysis as research design

The research objective of this phase in the study required the current views and suggestions from stakeholders on collection preference, distribution to recyclers, and mechanisms to regulate and promote a sustainable e-waste management system in South Africa. Qualitative content analysis, using an exploratory inductive approach, was selected as the research design for this phase of the study (Mouton, 2001:165-167).

Qualitative content analysis is a systematic analysis of a body of material with the aim of identifying themes and patterns (Zhang & Wildemuth, 2009:319). Amongst others, transcripts of interviews form part of human communication and can thus be subjected to qualitative content analysis (Leedy & Ormrod, 2005:142). Qualitative researchers use the inductive approach considerably as they make observations and then draw inferences about general phenomena. This is done by analysing textual data (e.g. interviews) from small samples, by searching for codes, categories and themes, and then communicating the findings through words and individual quotes. Qualitative research is not exclusively inductive in nature, however theory is generally formulated through the inductive reasoning process (Leedy & Ormrod, 2005:96).

A qualitative study normally involves an inductive approach to content analysis as it starts primarily with data obtained from the observations or interviews rather than theory or existing codes (Babbie, 2007:328). Content analysis is therefore a coding and categorising operation, where raw data is transformed into a standardised form; this involves operational and conceptual logic, which is linked to the conceptual framework the researcher developed (Babbie, 2007:325-326).

An inductive qualitative content analysis is an engagement with facts and specifics of the collected data where the purpose is to determine important categories, scopes and relationships between them. This is done by receiving and analysing data collected from open-ended questions (Patton, 1990:40). The ultimate purpose of qualitative content analysis is to develop, from the raw data, rich and thick descriptions, which will convince any reader of the trustworthiness of the results (Merriam & Associates, 2002:15).

In this study, the interview data collected and analysed for the qualitative phase was not used to test hypotheses or theory (deductive approach), but aimed to answer the research questions which were formulated based on the literature review and the formulation of a conceptual framework. Theory was thus developed through an inductive approach from analysis of the data. Although the data being analysed from the interview transcripts was guided by the research questions, the extracted codes, categories, and emerging themes from the data itself guided the process and directed the analysis.

In the preceding sections, it was made clear that content analysis can be used to do inductive analysis of qualitative data. The unorganised and limited knowledge in South African around the phenomenon under investigation called for this inductive qualitative content analysis approach from which new theory will be developed.

5.7 SELECTION OF PARTICIPANTS OF THE QUALITATIVE RESEARCH PHASE

5.7.1 Quantitative research sampling

In quantitative research, sampling is taking a randomly selected portion of the population to represent the entire population (probability sampling). In qualitative research, the interest is not on how representative participants are of the population but rather on concepts and incidents explaining the concepts (non-probability). The more variation of the concepts, the better the theory building (Corbin & Strauss, 2008:156). The purpose of sampling differs between the two research approaches. Non-probability sampling is where a researcher selects samples based on the subjective judgment of the researcher rather than random selection, which is done when researchers cannot select large scale probability samples, as in surveys (Etikan, Musa & Alkassim: 2016:1).

5.7.2 Sampling techniques

Babbie and Mouton (2001:166) state that different non-probability sampling techniques can be applied, however only purposive (or judgemental) sampling and snowball sampling were applied in this phase of the study. The same authors describe purposive sampling as sampling done when the researcher selects participants based on his/her knowledge and experience of the population, the elements in the population and the research aim; it is based on the researcher's judgement and the study purpose. Snowball sampling is done when research participants suggest other participants for a test or study and when useful members of a population are difficult to locate (Babbie & Mouton, 2001:167).

In the qualitative phase of the research, there was a need to interrogate knowledgeable and experienced participants who could give rich and insightful contributions to the study. The researcher used both sampling techniques to contact experts in the respective fields. Purposive sampling was employed as the researcher did a preliminary field investigation and could select participants who were identified as experts in their respective fields. Through the original informal discussions with stakeholders and consumers, and through observations of current practices of household e-waste management, locally and abroad, the researcher gained valuable knowledge. This knowledge and a review of the literature assisted the researcher to define the participant selection criteria, which will be discussed in the next section.

Although e-waste is an international problem, the population involved with e-waste in South Africa is relatively small. Only a few e-waste recyclers can be considered 'large,' but they are still small compared to global standards. E-waste associations are also limited to three. The researcher therefore conducted interviews with the biggest and most active role players in the industry. In some cases, the participants could direct the researcher to additional experts in the field from which interviews were arranged. Snowball sampling was consequently employed in some cases.

5.7.3 Participant selection criteria

Based on the purpose of this study, the participants were recruited from four distinctive groups, based on their specialist experience in some area of e-waste management. They were selected based on their extensive experience in the specific group setup with the aim to offer in-depth insights into the overall e-waste strategy. The contributions were not just the explanation or practical implementation of current practices or work scenarios, but extended to proposals for implementing workable strategies to manage e-waste effectively.

Table 5.2: Selection criteria for selected groups

Stake holder group	Criteria
Environmental specialists (ES)	- Active involvement in e-waste management efforts - Senior management/CEO
Government authorities (GA)	- Active involvement in waste recycling efforts (e-Waste included) - Management or specialist position
Recycling/ disposal entities (RDE)	- Senior management or CEO of recycling entity - Collector-CEO
Supply Chain members (SCM)	- Senior management or owner - International exposure to EEE importing

The selection criteria applied are summarised in Table 5.2. This ensured participants to the study had adequate experience in the e-waste environment and could contribute to the study.

5.7.4 Target groups

The goal of this study was to explore the experiences and views as well as suggestions from different sectors in the e-waste system. The ultimate aim was to develop a framework for the effective management of e-waste. Given the aim of the study, it was appropriate to target prominent and influential participants from different sectors in the e-waste system.

Each sector has its own unique set of skills and knowledge base from where they can contribute towards an e-waste management system. Each sector's participants know the limitations as well as capabilities in their own area and can contribute in areas where there are overlaps. Information rich suggestions could be expected with these diverse but knowledgeable participants. The target groups consisted of the following four role-players involved in e-waste management:

- **Environmental specialists** represent e-waste environmentalists, e-waste consultants and associations for e-waste recyclers. These specialists have experience, knowledge, an industry network of stakeholders and a passion to ensure that e-waste is recycled and disposed of in the correct manner. Interviews with four participants in this stakeholder group were conducted.
- **Government authorities** included municipalities (local government), provincial government, and central government - the Department of Environmental Affairs. The aim was to determine the judiciary role (if any) of authorities, the function of different government entities, the collection capabilities of municipal vehicles, and the suitability/capabilities of using a municipal refuse sites for collection and storage of e-waste. Interviews with nine participants in this stakeholder group were conducted.
- **Recycling/disposal entities** such as e-waste collectors, disposal entities, and recyclers, were approached for inputs and views. This group sees to the effective recycling and disposal of e-waste. The involvement of this group is important to determine best collection practices, recycling and disposal hurdles, shortcomings in their environment, and to listen to suggestions. Interviews with five participants in this stakeholder group were conducted.
- **Supply Chain members include** producers as well as traders. Producers are the main source of product knowledge to enable recyclers to recycle e-waste correctly and effectively. Traders or retailer are the intermediaries between producers and the consumer, and offer an important source of information about e-waste recycling. Consequently, producers and traders need to be involved in various areas of the management process to determine where and how they fit into the proposed management framework. Interviews with two participants in this stakeholder group were conducted:

- *Producers:* (SA manufacturers, importers and SA assemblers). Producers are the originators of the problem and their views and ultimate responsibility in the management chain needed to be determined. An interview with one participant representing producers in this stakeholder group was conducted.
- *Traders:* (Distributors and Retailers). They sell electrical and electronic equipment which will eventually become e-waste. As a point of sale, and normally situated geographically close to consumers, traders had to be involved with the management process. Involvement in collections of e-waste, financial responsibilities, and reporting measures needed to be explored. An interview with one participant representing traders in this stakeholder group was conducted.

5.7.5 Sample size

Creswell (2013:157) states that in an exploratory qualitative enquiry, which has an inductive approach, the aim is not to generalise information toward a larger population, but rather interpret the information received from a specific context and environment. Sample size is a debatable topic in the qualitative realm, but the main aim should be to collect enough detail from the study participants who were purposively selected. There are however different opinions on the number of participants needed for a qualitative study.

Corbin and Strauss (2008:148) advise that data should be collected until saturation is reached. This normally means that no new categories or themes emerge from the data collection. Saturation is however only reached when categories can be developed and have possible relations with other concepts.

In this research, the focus was soliciting information from various target groups to get an in-depth insight into the different perspectives and to ensure the saturation stage was reached. In this phase of the research, 20 participants were interviewed who represented all four of the stakeholder groups (as seen in Table 5.3). With the Government authorities, nine managers were interviewed. Two Metro cities were also selected for interviews; in Metro city 1, a single manager was interviewed, while in Metro City 2, three managers/specialists were interviewed. As Metro cities are large, persons involved in the waste sector have a dedicated focus.

The management were of the opinion that more managers (three in Metro city 2) could give a better picture of the whole if interviewed together. In the case of the interview with the provincial Government, the same sentiment was observed (four in this interview). The nine participants in the Government structures partook in four interviews.

More interviews would have been preferred with the supply chain members, however the researcher had difficulty in contacting participants in this group. The views and experiences of the two participants were however rich and insightful as both had extensive experience and knowledge of the international e-waste environment and ties with international companies. The international experience made the contributions from the two supply chain members more valuable than what interviews with local supply chain members would have produced. In the e-waste environment stakeholders do not operate in isolation and have contact and experience with stakeholders outside their own area of operation. Environmental specialists and recycling/disposal entities deal with producers and retailers, which ensured the views and experiences of the supply chain members would also be expressed during their interviews. The fact that two supply chain members were used in the study will thus not negatively affect the outcome of the study.

Table 5.3: Sample size per stakeholder group

<i>Stake holder group</i>	<i>Number or participants</i>
Environmental specialists (ES)	4
- Green Economy Company 1	1
- Green Economy Company 2	1
- E-Waste Specialist 1	1
- E-Waste Specialist 2	1
Government authorities (GA)	9
- National Government	1
- Provincial Government	4
- Local Government (Two Metro cities)	4
Recycling/disposal entities (RDE)	5
- Collector 1 (Individual)	1
- Collector 2 (Metro city)	1
- Recycler 1	1
- Recycler 2	2
Supply Chain members (SCM)	2
- Producer (Importer/Distributor)	1
- Retailer/Importer	1
<i>Total</i>	20

This sample size for this exploratory phase of study was deemed adequate since saturation of the themes was reached, and the variety of participants represented relevant specialists with extended experience in different sectors.

None of the selected participants indicated they wanted to withdraw from the study once they agreed to participate. Various attempts were made to involve more participants from the retailing sector, but the researcher managed to get only one retailer to participate. This participant was involved in importing (Producer), selling of electronic items (Retailer), and the repairing of items (Refurbisher). Contributions from this participant were consequently insightful and several suggestions were offered when analysing the data.

5.8 DATA COLLECTION OF THE QUALITATIVE RESEARCH PHASE

5.8.1 Semi-structured interviews as data collection method

The research method is the source to answer the research question. This implies the research method is dependent on the real research situation, and what would be the most effective to give the required data to answer the research question (Maxwell, 2013:100). The major data collection methods for qualitative research include interviews, observations and documents. It is therefore vital to determine which sources will provide the best answers to the specific research question/s (Merriam & Associates, 2002:12).

This phase of the current study relied on semi-structured interviews as the data collection method to address the first research question. Interviews range from highly structured, questions arranged beforehand and asked in a certain order, to unstructured where there are no questions or order, only the topic is known (Merriam & Associates, 2002:12-13). Interviews are classified into three types, namely *unstructured interviews* with no structured interview guide, *semi-structured interviews* which are pre-existing interview guides where participants are allowed to elaborate on topics and the interviewer can delve deeper into topics, and *structured interviews* where an interview guide with the same set of questions are given and no flexibility exists, similar to close ended survey questions in a quantitative approach (Corbin & Strauss, 2015:37-39).

The application of semi-structured interviews was aligned with the exploratory nature of this phase of the study and facilitated an understanding of the views, experiences, and proposed best practices of different stakeholders in the e-waste scenario on an effective management strategy for South Africa.

The discussions during the semi-structure interviews with these knowledgeable specialists allowed the researcher to understand and question their views. The reasons for what an ideal e-waste management should comprise and how this system should function in South Africa could be explored in-depth.

5.8.2 Approaching the participants

Qualitative research normally disrupts the participant's normal activities and participation should be voluntarily, while anonymity and confidentiality would be guaranteed (Babbie & Mouton, 2001:521-523). Gaining entry to interview participants starts with conveying trust, which can be difficult at times (Krathwohl, 1998:253).

All the targeted participants were initially contacted via e-mail or telephone; those contacted by phone were also e-mailed. In the e-mail, a letter from the North West University requesting participation was attached (See Annexure G). The purpose of the study was thoroughly explained in the email and a copy of the informed consent was attached (See Annexure H); this was to ensure participants knew what the study was about and that it would be anonymous and confidential. The ethical clearance (See Annexure I) was confirmed in the informed consent document and included in the e-mail. Participants who indicated their willingness to participate were then contacted by the researcher to determine suitable interview dates and a venue of the participant's choice.

After appointments were confirmed, the researcher e-mailed the interview questions, one week in advance (See Annexure D), to the participants to enable them to prepare for the interview. This ensured the participants knew exactly what to expect and were well prepared to discuss the topics, give their views, provide insights, share experiences, and contribute to the study. Participants were allowed to be prepared and at ease when the interviews were conducted.

The participants were ensured, at initial contact and during the interviews, that all correspondence and communication was confidential, irrespective of the information provided. They were also informed that a confidentiality agreement would be signed by both parties on the day of the interview and that the interview would take approximately one hour to complete.

5.8.3 Interview guide as measuring instrument

Creswell (2013:164-166) advice that an interview guide should be designed to have five to seven open-ended questions. The interviewer must follow the directions offered in the interview guide, stay within the arranged timeframe and most importantly, be a good listener. An interview must start with an introduction to remind the interviewer of points to mention to the participant. After the introduction, opening questions should be asked to build rapport with the participant, followed by the key questions of the research including probing questions. The interview guide should stop with a closing question/s (Hennink, Hutter & Bailey, 2011:112-114).

The semi-structured interviews with the different stakeholders in the e-waste environment were conducted using an interview guide. The interview guide (Annexure D) was e-mailed to the participants in advance and had the same questions and topics as the one used by the researcher during the actual interviews, the difference was the inclusion of additional probing questions to explore specific issues. Should the participant not clearly address the issue, the researcher would use a probe to enable him to get clarity. Using an interview guide ensured that all the issues pertaining to this study were covered (See Annexure E). Using the interview guide ensured confidence within the researcher as all topics would be covered, eliminating the possibility of unfinished or unanswered questions. As more interviews were completed, the researcher gained more experience and increasing skills to probe for more and in-depth information. The interviews were conducted in the following phases from the interview guide:

- ***Before the interview***

The researcher introduced himself to the participant/s and engaged in informal conversation to set the participants at ease. All the detail in the informed consent form were discussed before the participant/s signed the document.

The researcher began the discussion by giving a short introduction on why the research was undertaken on household e-waste management in South Africa.

The introductory questions focused on a description from the participant on the type and size of organisation of which he/she belonged, and their role and position in the setup.

This provided some background to the participant's knowledge and experience in the e-waste sector and notes were later made to capture the information.

- ***Starting the interview***

The interview began with the date and time, which was mentioned for recording purposes. The recordings were used so that transcribing could be done at a later stage after which analysis would follow. The researcher made some notes if the participant made a point that needed further investigation and was not included in the probing questions.

- ***General issue questions and additional probing questions***

Care was taken during the design of the interview guide to avoid bias. The interview guide was presented to the co-supervisor of the researcher who is a qualitative research expert. The purpose was for her to review the content, structure and wording. Recommendations were given and changes were made.

Table 5.4 summarises the main topics and the different questions posed to the participants. From the literature review, some issues were identified and discussed. The questions for the interview guide were then developed to receive feedback from participants. The three main topics that were highlighted were:

- Collection of e-waste from household consumers.
- E-waste distribution to recyclers.
- Mechanisms to regulate and promote a sustainable e-waste management system in South Africa.

The interview guide also included probing questions to obtain an in-depth understanding of their views and practices (See Annexure E).

Table 5.4: The interview guide

TOPIC 1: COLLECTION OF E-WASTE FROM HOUSEHOLD CONSUMERS	
	<i>Intro: I would like your view on e-waste collection of e-waste from household consumers</i>
1.	In your opinion, what should the responsibility be of household consumers of electrical equipment when the items become e-waste and have to be discarded?
2.	Which collection methods or places will be suitable and safe for the South African environment to collect large and small household e-waste? (Please discuss this in terms of urban and rural environments)
3.	What is your view on a reward system to encourage consumers to return household e-waste items, and if you support it, what should the reward system look like and how should it be implemented?
TOPIC 2: E-WASTE DISTRIBUTION TO RECYCLERS	
	<i>Intro: Collection points are used for different types of household e-waste. SA recyclers also focus on different types of e-waste. I would like your view on e-waste distribution to recyclers.</i>
1.	Who will have to ensure that the different e-waste streams are separated and how/where should the e-waste separation be conducted?
2.	Irrespective of where the separation of the different e-waste streams is done, who should be responsible for the transport of the e-waste to the recyclers?
3.	To your knowledge, in which areas is there still a lack of e-waste recycling facilities, and what can be done to address the shortcomings?
TOPIC 3: MECHANISMS TO REGULATE AND PROMOTE A SUSTAINABLE E-WASTE MANAGEMENT SYSTEM IN SOUTH AFRICA.	
	<i>Intro: The government indicated that an EPR system should be the way forward, which implies a mandatory system. I would like your view on mechanisms to regulate and promote a sustainable e-waste management system in South Africa.</i>
1.	Do you foresee a Take-Back programme (for same category items), how should it be implemented, and who should manage it?
2.	How should the management of an EPR system for e-waste be funded and who should manage the funds?
3.	As part of an EPR programme, the norm is to have PRO's. What is your view on PRO's (is it necessary?) and PRO grouping for the South African scenario?
4.	In terms of the management of the system, who should be in charge of the different aspects of the e-waste system? Probe for the following: - the storage, collection and transport logistics; - communication between stakeholders; - the financial management; - treatment/accreditation; - setting of Performance standards; and - setup and management of a registry to capture/register all stakeholders.
5.	What is your opinion on the role of Government in order to ensure an e-waste management system?

The three major topics remained the same for all the interviews. The order of the questions remained the same, but the probes were adjusted depending on the area of specialisation. The conversation flow, as well as the environment in which the participant operated influenced the type of probes applied. General practices to collect quality detailed data were followed. This included listening carefully to participants and encouraging techniques to extract more information such as nodding, using encouraging sounds (“Ok”, “mmhm”) leaning forward and making eye contact (Hennink, Hutter & Bailey, 2011:124-129).

Specific guidelines from Patton (1990:283) were followed when conducting the interviews:

- ***Using an interview guide:*** The researcher compiled an interview guide, based on the literature and the research questions. The guide contained open-ended questions and potential probing questions. This ensured that all possible issues could be addressed during the interviews. The topics/concepts that needed to be discussed were captured in this conversational guide. Each interview however had unique answers and probing scenarios.
- ***Appropriate selection of interviewees to ensure that relevant information is provided:*** All participants were thoroughly screened by taking into account the position of the participant, to ensure the interviewee possessed the proper knowledge, experience, and position in his/her area of expertise. Only experienced managers or professionals (in cases of individuals, e.g. environmentalists) were included in the study.
- ***Finding a suitable location/setting:*** After arranging the interviews, the researcher enquired about suitable venues. It was explained that the interviews needed to be conducted in an area where there would be no interruptions or disturbances. This would ensure the interview would be completed in the minimum time and the recording of the interviews would be clear to prevent any transcribing problems. Participants arranged the venues, which was acceptable due to the neutral location and the fact that it would be quiet for the sake of the recordings.

The researcher printed a notice stating, "Recording in progress, please do not disturb," which was placed on the doors of the interview rooms after permission was received from the participants. In some cases, the location was close to noisy areas but the sound quality of all the recordings was good enough for reliable transcriptions. In one case, magnetic interference from a mobile home telephone caused the recording to be unusable. A cellular phone was used as a backup recording device; this device had no interferences and the recording could be transcribed.

- ***Establishing and maintaining rapport:*** All interviews started with informal conversations to set the participant at ease. The participant was asked to give his/her experience and background in the e-waste industry. The qualitative interviews sometimes became informal, as participants were passionate about their area of expertise. The interviewer allowed this, so as not to alienate the interviewee, but made sure that all the topics and issues as listed in the interview guide were covered.
- ***Be neutral and non-directive:*** During the interviews, bias was minimised and guidelines from experts were followed to ensure data integrity. This was done to ensure validity, transferability, dependability and authenticity. The interviewer took care not to give comments or hints about his views, which could lead participants into some direction. All interviews were digitally recorded and then transcribed.
- ***Allowing flexibility:*** The interview guide was used as the discussion guideline, but flexibility and free flow of discussions were allowed when needed. The researcher allowed this to happen as it gave an indication of the priority and importance of topics as experienced by the participant.
- ***Avoiding interviewer bias:*** Subjectivity or researcher bias is a threat to validity of qualitative conclusions. Bias is the selection of data that stands out, or data that fits the goals and existing theory of the researcher. Beliefs and researcher theories cannot be eliminated but negative consequences should be avoided. Validity is about integrity, not about indifference (Maxwell, 2013:124). A participant could be biased by the manner in which the interviewer reacts. This could be by means of body language or excessive agreement via nodding.

The researcher pertinently focused on acting neutral and in an unbiased manner during the interviews to counter potential bias. The researcher refrained from voicing his opinions during the discussions and ensured no comments were made that could indicate his personal preferences or opinions. Interviewer bias was thus reduced to the minimum.

- **Avoid response bias:** Researchers are biased in nature and there is no bias-free design (Janesick, 1994:212). When interviewees respond to questions in a socially acceptable manner based on interviewer bias it is labelled as response bias. This can occur if sensitive issues are dealt with. In the e-waste scenario, it can occur when stakeholders, out of fear or other reasons, prefer to keep the status quo. The discussions revealed confidential and sensitive information, such as illegal e-waste practices or knowledge of it, disagreement with current practices, and antagonism against persons and organisations. All participants were informed beforehand through an e-mail and by the researcher that the research being conducted was for academic purposes only. All interviewees were assured they would remain anonymous, the details of their organisation would be confidential, and that the discussions would be treated with the necessary confidentiality. The interview guide was set up with a qualitative research expert to try and build in more objectivity. Response bias was thus reduced to a minimum by implementing these measures.
- **Analysing when interviewing:** For the researcher to be sure that comprehensive data was collected during interviews, the preceding interviews were mentally analysed and brief notes were made after each.

5.9 DATA ANALYSIS AND REPORTING OF THE QUALITATIVE RESEARCH PHASE

It is difficult to keep the collecting and analysis of data separate in qualitative research. As soon as data collection commences, the researcher starts with initial analysis, as there will be a mental review of the interview and the recording/transcribed data. Although researchers differ about this, it is suggested that in-depth analysis starts only when all the data has been collected (Seidman, 2006:113).

Interviews generate large amounts of text, which must be reduced to what is of interest and most significant. This must be done inductively and with an open mind (Seidman, 2006:117).

There is no formula to transform qualitative data into findings, only guidance. The challenge is to make sense of the data by ignoring the trivial, identifying patterns, and then create a framework, which will help to communicate the core of the data to readers (Patton, 2015:521).

Coding is the common word used for qualitative data analysis. The aim is to get to a higher conceptual level by working with raw data. Coding requires analytical techniques, which involves interaction with the data, questioning data, and comparing data. The purpose is to develop concepts for the data and then develop the concepts in terms of their dimensions and properties (Corbin & Strauss, 2008:66).

Conceptually, similar incidents in different data sets must be grouped together. In this way codes, categories, and themes can be differentiated from another. It is sometimes necessary to group data in codes by making use of theoretical comparisons. This implies that the data being analysed does not directly fit into a code but can be assigned to a code based on the meaning of the text (Corbin & Strauss, 2008:73-74).

Qualitative research reporting takes a lot of time to prepare, because it is detailed and highly unstructured. The researcher must therefore be focused, use sufficient but succinct descriptions, and include essential direct quotations (Patton, 1990:429-430).

Detailed and “thick” descriptions were provided in the qualitative analysis chapter, Chapter 6. This was possible due the cautious selection of participants, who had relevant and extensive experience and an active and in-depth engagement with the participants during the interviews. This was followed with meticulous analysis of the data to develop codes, categories and themes. The analysis process was done while involving a co-coder who was a registered research psychologist and practices as an independent consultant within the field of social sciences. This was to ensure that there would be trustworthiness within this particular study.

Readers of the analysis chapter, Chapter 6, can understand the actual words of the participants and the context in which they were given, as the researcher included verbatim quotes and the context in which they were used as part of the analysis and the evidence trail.

5.9.1 Qualitative content analysis procedure

Once the data from a qualitative enquiry has been collected, the process of analysis and interpretation needs to be done. The first step in the processing of data is data reduction, while the second involves data analysis. In data reduction, the data is summarised, in data analysis, thematical and content analysis processes are applied; this is then concluded with synthesis, which is a process of explaining and interpreting of the data (Mouton, 1996:67).

Qualitative researchers have to code, but qualitative research is not about coding only. Coding means a reduction of data, but for qualitative researchers it means a retention of the data from which patterns and explanations can be understood (Richards, 2009:93-94).

An inductive analysis of qualitative data starts with codes, which have been derived from the data, i.e. transcripts. From codes, categories are created and from categories, themes are created. A code in qualitative analysis is sometimes a word or a short phrase, which is assigned to a section of the data and is a symbolic, collective, striking, “essence-capturing, and/or evocative attribute” to a section of the data (Saldana, 2015:4). Categories group these codes and represent a relatively discreet segment (variable) of the data. A theme is a sentence or a phrase declaring or describing a connection, a process, or some insight (Rossman & Rallis, 2017:239-240).

For an exploratory qualitative content analysis, which uses an inductive approach, the qualitative content analysis is an accepted data analysis method. The purpose is to analyse data and arrange them into codes. The codes would then be arranged into different categories and finally the categories would be arranged into themes. The themes would then be used to develop theoretical concepts.

The aim of the study is to develop a framework for the management of e-waste in the South African environment. Different aspects of the value chain must be incorporated, and the use of the qualitative thematic analysis enabled the researcher to understand and arrive at conclusions from a complex arrangement of different sectors in the e-waste arena. To understand how the different aspects of e-waste management can be integrated, a holistic, in-depth, systematic and rule-based approach is needed. Content analysis is complying with all these requirements and ideal for this study.

Based on the procedures for qualitative content analysis as described, the following steps were followed (adapted from Rossman & Rallis, 2017:237-249).

Step 1: Arranging the data

A verbatim transcription of each interview was made. This was done from the digitally recorded interviews with the various specialists. To ensure audible quality and to prevent recording device failures, the researcher used two different recording devices, a digital recorder and a cellular phone using a recording application. For the type of analysis that needed to be conducted, the researcher did not transcribe sounds, delays, noises or other audible conduct. Specific questions in the interview caused gestures from the participants, but the verbal responses expressed the feelings/attitudes of the participants on the matter. Probing questions were used if the matter under discussion was not clarified. The researcher chose beforehand not to report body language gestures, such as excessive hand throwing in the air and rolling of the eyes. The researcher verified the correctness of the data by comparing all the transcriptions while listening to all of the recordings several times.

Step 2: Familiarise with the data

As all the interviews were conducted by the researcher and all the interview transcripts were verified by him, he used this opportunity for familiarising with the data. The researcher analysed each transcript again to be more acquainted with the data.

Step 3: Code and category development from the data

The researcher attended training on qualitative coding principles as well as on the software package ATLAS.ti (Version 8). The Atlas.ti software was used to import all the transcriptions (primary documents) for the analysis of the data.

The transcribed documents were analysed numerous times. Codes were generated and data connected to these codes during each analysis phase; as new codes materialised they were captured as the coding continued. To ensure reliable and valid extraction of the codes, categories, and themes were done by the researcher used a registered co-coder.

The co-coder gave his views on the coding applied by the researcher and some codes were changed, while others were combined. A final version of the codes, categories, and themes were developed by the researcher and approved by the qualitative co-coder. With the guidance received from the co-coder, a consistent and reliable system was in place to develop codes, categories and themes for all the transcripts. During the analysis, 39 codes were generated and 16 categories.

Step 4: Generating themes

Collected data is combined into codes and categories, and the third level is themes/concepts. Themes are the highest form of consolidated meaning. The next stage would be to make assertions or to develop theory. Data is transformed from the real to the abstract (Saldana, 2015:14). From the 16 categories, seven themes were identified. The result was achieved after a thorough process of analysis and consultations with the co-coder and the qualitative supervisor.

Step 5: Interpreting the data and writing the analysis chapter

The analysed data, which resulted in final themes, were captured in Chapter 6. As suggested, the qualitative analysis chapter concluded with sufficient but succinct descriptions as well as essential direct quotations from participants.

Figure 5.2: The thematic data analysis process-Schematic

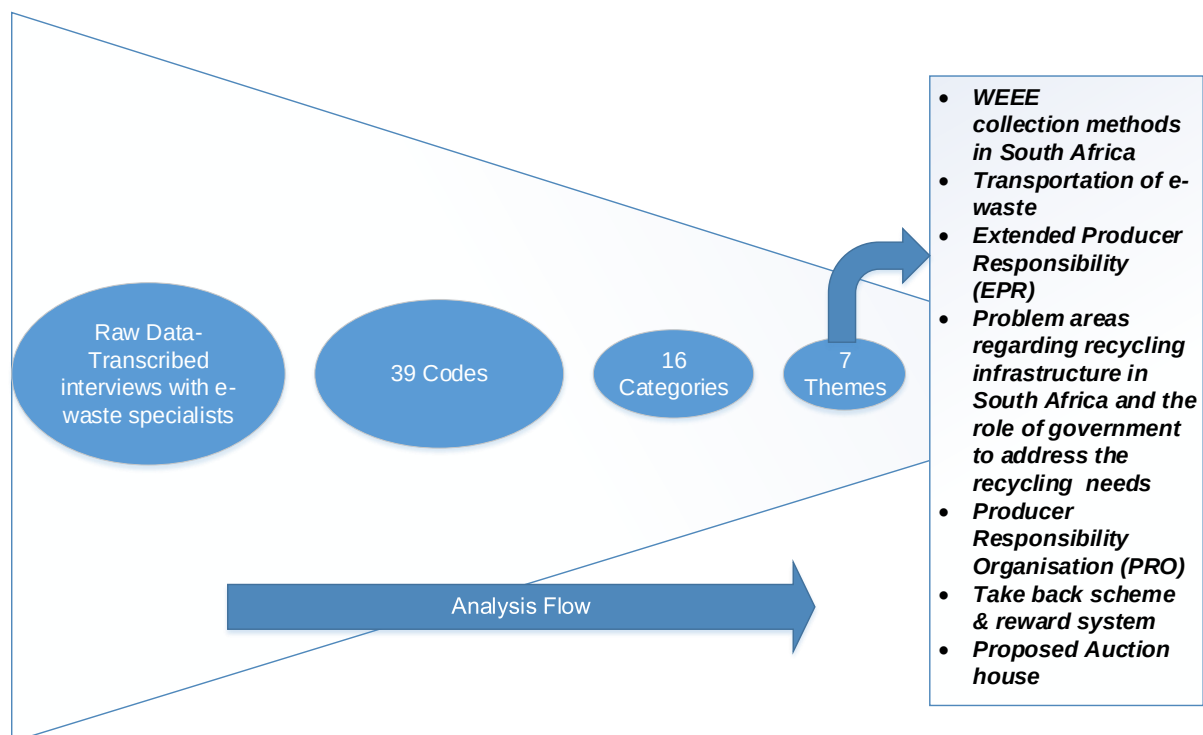


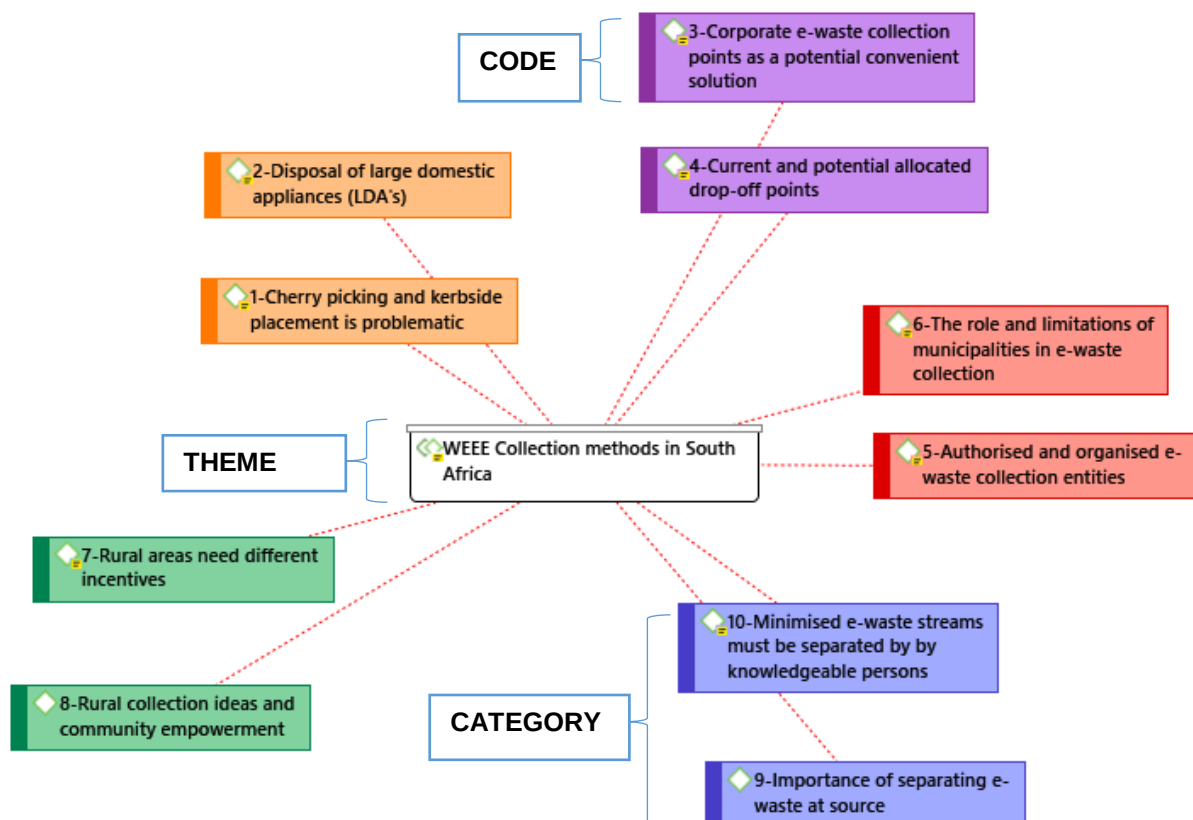
Figure 5.2 is a schematic representation of the process, which was followed to do qualitative content analysis on the data.

5.9.2 Software package and displayed data to report qualitative findings

Although the correct use of words can bring life to numbers, a graph and charts can give a holistic view and help to grasp what is important instantly (Krathwohl, 1998:391-392). Today there are many software packages available, which can assist researchers' in the analysis of the transcribed data. A software package such as Atlas.ti can use almost any type of document that needs to be analysed and can generate graphs to accompany the analysis. Software packages do not extract words or ideas, the researcher has to do the coding and the thematic development; software is only a tool to help a researcher, it cannot analyse the data (Rubin & Rubin, 2012:239-240; Flick, 2006:349).

The hermeneutics software package, ATLAS.ti (Version 8), was used for the analysis of the qualitative interviews. From the transcriptions, meaningful and contributing segments were identified and coded. The codes were analysed for general similarities and then grouped into categories. Finally, the categories were analysed for higher order connectivity and grouped into themes. The use of ATLAS.ti allowed the researcher to present the findings using visual display, such as conceptual network diagrams. This enriched the findings by helping the reader to better understand and visualise the findings. From the seven themes derived during the study, seven conceptual network diagrams were also developed. Figure 5.3 is an example of one of the themes developed using Atlas.ti. Each of the coloured blocks is a code while the different colours indicate different categories; the middle block is the main theme of the network.

Figure 5.3: Conceptual network of the integration of the codes, the categories, and the themes



5.10 ENSURING THE QUALITY OF THE QUALITATIVE RESEARCH PHASE

Patton (2015:677) argues that if quality must be judged, then there must be specific criteria to be judged against and credibility will then flow from these judgements. The same author stated that different qualitative enquiries and audiences call for different criteria to judge quality and credibility.

Some scholars aimed to overcome the lack of consensus by efforts to develop checklists incorporating the diverse criteria of credibility (Tong, Sainsbury & Craig, 2007:349), while Fitzpatrick (2019:215) has an opposing view.

The purpose of a research study is to produce findings that are “sufficiently believable” for others to use and improve social circumstances. The findings must therefore be trustworthy and potential users must believe in the integrity of the findings. Historically, the criteria to judge a study was reliability, generalisability, validity and objectivity. Since then alternative measures of trustworthiness have been proposed (Rossman & Rallis, 2017:50).

Lincoln and Guba (1985:289-328) suggested the use of key criteria, namely credibility, dependability, transferability and authenticity to evaluate the quality of qualitative studies. In the sections to follow, these criteria will be explained as well as how it was addressed in this study.

5.10.1 Credibility

Credibility (or internal validity) is established when a reader is transported into a situation or setting where the detailed account received from the researcher allows him to generalise and make connections between his own experiences and that of the narrative of the researcher (Creswell & Miller, 2000:129).

The use of rigorous fieldwork methods, the researcher’s credibility, qualitative methods, inductive analysis, holistic thinking, purposeful sampling, and the fundamental appreciation of naturalistic inquiry are the fundamental principles enhancing the credibility or internal validity of a qualitative report (Patton, 2002:552-553).

To enrich the credibility of the study the researcher implemented the following strategies:

- An in-depth literature review of e-waste practices was done locally, and in other countries. The findings could thus be structured and conceptualised around the literature review.
- Interviews, an appropriate qualitative research method, were used to collect the primary data from specialists in their respective field. This was the most suitable method to obtain credible, honest, and insightful data from participants in the qualitative phase of this research.
- An interview guide with probing questions was used and listening techniques applied during the in-depth interviews. The aim was to extract maximum meaningful data from the specialists. Where discrepancies occurred during an interview, the researcher applied questioning techniques by revisiting previous matters which needed clarity.
- Purposive sampling was applied to select specific specialists in four shareholder groups based on their credentials. The researcher had brief interactions with three of the participants during the initial investigation phase and they were selected based on their expert knowledge and years of experience in the e-waste environment. Apart from these three, participants had no link of any kind with the researcher; this ensured the researcher was not biased when selecting the participants. During the preliminary investigation, the researcher interacted with numerous persons. Many were not included in the final research phase as the researcher focused on participants who could make valuable contributions and give credibility to the study.
- The researcher applied tactics to enhance the honesty of participants by doing the following: 1) ensuring participants that the interviews were confidential and would be reported anonymously, 2) participants were given an opportunity to refuse participation and were assured they could withdraw from the study at any time without explanation, and 3) participants were assured there were no right or wrong answers and encouraged to share opinions. This contributed to minimising participant reluctance to share, thus increasing feedback on their knowledge and opinions.
- Credibility can be enhanced by ensuring that findings are compatible with reality. One of the strategies for internal validity is “saturation,” meaning that the researcher heard the same thing multiple times; enough participants must be interviewed to get to this point (Merriam & Associates, 2002:26). Saturation was reached during the interviews as similar responses were received from participants.

- Inductive content analysis was applied to develop the initial codes from the interview transcripts and to derive at the themes. ATLAS.ti was used to aid in the transparent coding process and to draw final inferences from the primary raw data.
- The researcher ensured he was competent in doing interviews by completing two different interview technique courses, which gave him the necessary training. The training involved practical sessions where course attendees acted as interviewers and interviewees. This role playing helped to prepare the researcher for possible obstacles that might occur during interviewing, such as deviating from the discussion points in the interview guide.
- Single researcher bias was reduced by having discussion sessions with the qualitative supervisor and with the co-coder on a continuous basis. This was to receive guidance and ensure credibility of the research.

5.10.2 Dependability or consistency

Dependability refers to the detail reporting of processes within a study to enable future researchers to repeat the study, even though they will not necessarily get the same results. Shenton (2004:71) suggested that a prototype model must be created to allow readers to use the in-depth coverage to assess the appropriateness of the applied research practices.

In reality, it would be impossible to obtain exactly the same results in a qualitative study as new researchers would arrive at different conclusions and new participants would give similar or contradicting views and additional interpretations (Merriam & Associates, 2002:27). A positivist's belief of reliability assumes that the universe is not changing and replication of an enquiry is possible. The qualitative/interpretive view is just the opposite, making replication problematic (Marshall & Rossman, 2011:253).

Reliability in qualitative research was conceptualised by Lincoln and Guba (1985:288) as "dependability" or "consistency," and their conclusion on the issue is that the interpretation of the data that has been collected must make sense to others. The focus should therefore not be on getting the same results if replicated.

Merriam and Associates (2002:27) concur by pointing out that that in qualitative research the results must be consistent with the collected data. According to Dey (1993:251), the best way to defend your results is to have an audit trail to explain how they were derived.

The following techniques were applied to ensure the dependability and consistency of this study:

- A detailed and accurate account was given of how the research was designed and implemented.
- A detailed account was given of the data collection and data analysis processes.
- A reflective appraisal of the project was done. The researcher critically evaluated the effectiveness of the processes applied during the enquiry and implemented improvements when needed.

5.10.3 Transferability or external validity

Transferability, or external validity, is possible if one uses in-depth analysis of situations and transfers that to other situations (Merriam & Associates, 2002:28). Transferability refers to the usefulness of study findings to others researchers in similar situations, e.g. similar research questions. The burden to show that research findings from an original researcher applies to other contexts lies with the “secondary” researcher who would like to use those findings (Marshall & Rossman, 2011:252). Lincoln and Guba (1985:225) has an opposing view and places the burden of proof on the original investigator and not on a “secondary” investigator who wants to apply the findings. Their argument is that the original investigator does not know to which environment transferability is required, but the “secondary” investigator does. For this to be possible, the primary investigator must give adequate descriptive data, which will enable transferability.

The transferability of the study was enhanced in the following ways:

- The theoretical model and the conceptual frameworks of the study were discussed in detail during the literature review. The research questions were based on this theoretical/conceptual background to ensure consistency.
- The research design and methodology were described in detail to allow the study to be repeated, perhaps in another developing country.

- The purposive sampling and an explanation of the selection criteria of participants was given and justified in detail.
- The reader should have clarity as the data analysis process was described in detail.
- A detailed description was given of the application, the use of analytical methods, and how the results were validated, by peer checking from the supervisor and the co-coder, by constantly returning to the original transcripts.
- In the qualitative analysis chapter, Chapter 6, detailed description was given of the type and number of participants from different organisations who took part in the study, the length of the interview sessions, and how care was taken to ensure correctness of the transcriptions.
- A detailed description was given of how the results were interpreted.

5.10.4 Authenticity

Authenticity, or construct validity, refers to a valid depiction of a narrative as told by the participant. The narrative should not be tainted by the researcher's views or bias. The experiences of situations and the importance of topics as understood by participants must be voiced correctly through correct data collection methods and analysis (Flick, 2006:372). Shenton (2004:72) used the term "confirmability" for the same concept, which refers to the steps taken to help ensure that the experiences and ideas of the informants are reflected in the findings and not the preferences and characteristics of the researcher.

Authenticity of the qualitative research phase was achieved through the following:

- The participants were interviewed in a setting of their choice and confidentiality and anonymity was guaranteed before the interviews commenced. The environment was known and safe to participants, which enabled an honest sharing of experiences, opinions, and suggestions.
- The semi-structured interviews allowed the researcher to use probing questions to get an in-depth understanding of the original, sometimes innovative, ideas from participants.
- By making use of an inductive approach while analysing the data, the "voice" of the participant was extracted and presented.

- According to Patton (1990:12), the purpose of applied research is to enhance decision making, to advise on action plans, and to apply the knowledge gained through the research to solve social and human problems. Very little information and research exists in South Africa on effective e-waste practices, management processes are non-existent, and no sustainable plan is available to ensure the effective management of e-waste in South Africa. These are the drivers, which encouraged the researcher to address the problem. Participants were eager and willing to share their experiences, thus contributing to the authenticity of the research.

5.11 RESEARCH ETHICS OF THE QUALITATIVE RESEARCH PHASE

The purpose of interviews is to collect data for interpretation. The feelings and observations of interviewers can become entangled when data is collected. When designing and implementing a qualitative study the researcher must deal with some ethical issues. Promises from the interviewer must be kept, risks should be minimised, confidentiality agreements must be honoured, informed consent must be received, and access to participants and data should be clarified to ensure the researcher conducted the study ethically (Patton, 1990:354-356).

During the study, ethical considerations were given to the following issues:

- **Access and consent:** All participants were contacted via telephone and and/or e-mail and informed about what the study entails and then requested to be interviewed. Appointments were made and the duration of the interviews and the nature of the study explained. Prior to the interview, the interview guide was e-mailed to all interviewees (See Annexure D), and before the start the participants were assured of anonymity and confidentiality, and the informed consent was completed (See Annexure H).
- **Ethical approval:** The study was formally approved by the Engineering Research Ethics Committee of the North West University on 27 March 2017. The qualitative side of the study involves adult participants of sound mind who are specialists in their field, thus consent was directly obtained from them. Ethics number: NWU-HS-2017-0063.

- ***Inclusion criteria:*** The main target groups/stakeholders and the entities to which they belonged were identified. Experts in these fields were included in the study as they are knowledgeable and experienced and could positively contribute to the study.
- ***Competency training:*** The researcher attended specific training courses on qualitative research, which included ethical considerations. This practical training guided the researcher on how interviews should be conducted and data analysed in an ethical manner.
- ***Collection of data:*** The data-collection process was accurate, comprehensive, and detailed. From preceding interviews, vignettes were used to extract information from participants. The sources were not revealed and the assurance of anonymity and confidentiality were kept. All participants agreed to a convenient time and place for the interviews to be conducted. Appointments were confirmed via e-mail and the participants were telephonically contacted before the interviews. This sometimes happened a few days before the interviews as the researcher had to fly to Cape Town and Durban. Participants were informed they could withdraw from the study at any time, during or after the interview, should they feel uncomfortable. Participants were not pressed to give answers and were assured that the interview would end at the scheduled time. No participant withdrew from the study or expressed any uncomfortable feeling during or after the interviews.
- ***Interview recording:*** Details of participants were recorded on a laptop but the files were immediately password protected. Participants were then assigned a code, which became part of the data. The interviews were recorded on an electronic recording device and a cellular phone to ensure that technical problems did not prevent the capturing of what was said during the interview. The recording devices were kept in the possession of the researcher at all times. The recorded sound file was stored and password protected on a USB drive as well as on Google drive/Dropbox soon after the interview were conducted. This was to ensure the data was secure and protected from being lost. The recorded interview was then deleted on the recording device. The details of the participants were only known to the researcher.

- ***Processing and storing of data:*** The details of the interviewee were not given to the person doing the transcribing. The transcribing of data was done by a private transcription services company, referred by the statistical consultation services at North West University. The recordings of the interviews were exchanged via Dropbox, transcribed by the company and the returned transcriptions stored and password protected. Data that needed to be analysed by the researcher was done on his laptop and password protected. Disseminated data were presented in this thesis while care was taken that findings, or the quotations, did not point to any individual. The researcher was confident that the measures ensured the confidential handling of the data and information of all participants, consequently ensuring anonymity.
- ***Data analysis and reporting:*** No transcriptions will be publicly available, meaning they will not be included in the thesis. Only quotations from participants will be loaded onto a compact disc and attached to the thesis. The researcher did not report the data selectively and remained objective during the data analysis and interpretation, thus producing reliable findings and maintaining his research integrity.

5.12 CONCLUSION REGARDING THE QUALITATIVE RESEARCH PHASE

In the sections above, the qualitative research design used in the study has been discussed and explained. Qualitative content analysis using an inductive approach was used. The use of purposive sampling to select experienced and expert participants in the e-waste environment has been explained. The use of semi-structured interviews to collect data were highlighted, as well as the use of a thematic analysis approach on the transcriptions. The use of Atlas.ti to assist with data analysis, as well as to produce graphical presentations, were discussed. The way in which qualitative data was interpreted and reported were explained. This section of the chapter concluded with a detailed description of criteria used to ensure the quality and trustworthiness of the findings and indicated some issues that were considered to ensure the study was conducted ethically. In the following three chapters, 6, 7, and 8, the qualitative analysis, the quantitative analysis, and the combined/mixed analysis of the data will be presented.

5.13 THE QUANTITATIVE PARADIGM OF THE RESEARCH PHASE

In section 5.5, the three major research paradigms were introduced. They are 1) positivism, 2) interpretivism, and 3) critical theory. According to Babbie and Mouton (2001:49), the quantitative research is linked to the positivist paradigm. The positivism research paradigm is characterised by quantifiable analysis of human behaviour and control for sources of error in the research process, through experimental designs or statistical control. In this quantitative phase, the positivist paradigm will be used to obtain quantifiable data from consumers living in urban areas. The feedback from consumers will be quantified into factors which will be used to measure the attitudes, perceived behaviour control and behaviour intention in dealing with e-waste. These quantifiable factors will then be used to do hypotheses testing.

5.14 RESEARCH DESIGN OF THE QUANTITATIVE PHASE

5.14.1 Descriptive cross-sectional research design

According to Mouton (2001:55-57), a research design primarily focuses on the type of study being conducted and how the researcher will get the best answers to the question/s that were formulated. It is a blueprint of how the research will be conducted and where a survey is being used; it is broadly categorised as an empirical study using primary data. Singh (2007:64-65) defines quantitative research broadly as either *exploratory* or *conclusive* in nature. Exploratory research forms the basis, after which research that is more conclusive must still be conducted. Conclusive research includes descriptive research, where descriptive data from the studied population is enumerated. A causal relationship between events is thus not established. An event or happening is described, or a factual and accurate account is given of the population being studied. Things are measured and the frequency and average number of occurrences are represented in descriptive research.

The quantitative phase of this study employed a descriptive research design, as a broad overview was needed from a representative sample of a large population (Mouton, 2001:152). In this study, the representative sample consists of urban household e-waste consumers.

Singh (2007:65) explains that descriptive research can follow different approaches, namely case studies, case series studies, cross-sectional studies, longitudinal studies and retrospective studies. The cross-sectional approach is most commonly used with surveys and data is collected at a single point in time. A snapshot is taken of the established phenomena, and relationships between variables of interest are assessed only once. The cross-sectional approach has been followed in the quantitative phase of this study as the phenomena needed to be tested currently. There is no need to test variables over time, as there has been no measures being implemented to bring changes in the e-waste scenario over the last decade. Should the proposed framework of this study be implemented, a longitudinal study can be conducted in the future with the same set of questions to determine if any changes between variables and behaviour Intentions occurred.

Quantitative research can be seen as a “variance theory,’ where statistical relationships between variables is explained (Maxwell, 2013:29). Quantitative research typically applies a deductive approach, where hypotheses are tested after they have been derived from theory (Patton, 1990:40). Quantitative research is aimed at determining things about the social world, such as the degree of existence of a specific social quality. It can also be used to determine the relationship between two or more social qualities (Phillips, 2006:283). In the quantitative phase of this study, the degree of existence and the relationships between qualities were measured and nine formulated hypotheses were tested. Consequently, a quantitative study, using descriptive research and a cross-sectional approach, was used to collect and analyse the data.

5.14.2 Data sources

Mouton (2001:69-71) describes primary data as data which exists or which has been collected by the researcher. Data can be numerical information or quantitative, such as responses from surveys, test scores and medical measures. Secondary data refers to written sources, such as books, articles and the internet. When sources are consulted to get an informed opinion, which can assist the researcher, they are referred to as secondary sources.

5.14.2.1 Secondary data sources

Secondary data sources must first be examined before the primary data can be collected (Malhotra & Birks, 2007:94). During the quantitative research phase, the analysis of secondary data sources helped the researcher with the following:

- Defining the problem investigated
- Selecting the best research designs and approaches
- Identifying the constructs needed for a South African study
- Identifying the TPB as most appropriate theory to develop a conceptual framework and hypotheses
- Designing a measurement instrument
- Developing a plan to do the sampling
- Analysing the data and to determining relationships between key constructs

5.14.2.2 Primary data sources

To collect primary data, the researcher made use of a research firm to collect data from respondents living in urban areas (all the large cities were included). A survey was done by distributing a questionnaire online using the database of the research house. Respondents older than 18, and living in urban areas were targeted. E-waste is part of every citizen in South Africa, meaning almost any urban consumer could contribute to the study. All the research objectives were met after the data were collected and analysed.

5.15 SAMPLE DESIGN OF THE QUANTITATIVE PHASE

Sampling refers to selection of an appropriate sample representing the population from which it is taken. The purpose is to determine characteristics and parameters for the entire population (Singh, 2007:102). The guidelines for the sample design process, as suggested by Malhotra and Birks (2007:406-410), were applied in the quantitative phase of this study. These guidelines are presented in the following sections:

5.15.1 The target population

The target population of this research entailed adults 18 years and older who resided in urban areas of South Africa, and who have used any type of electronic or electrical equipment in the past year. Only those respondents who met the above criteria were permitted by the research firm to complete the online survey.

5.15.2 Sampling frame

A list of names of all the elements of the target population is called a sampling frame (Curwin & Slater, 2004:266). Since in this research the population is urban respondents who use electronic or electrical equipment, which is millions of people, a list is not available. A sampling frame for this research was therefore not be used.

5.15.3 The sampling technique

A census includes the whole population, whereas a sample is a selection from the population in which there is an interest (Curwin & Slater, 2004:264-265). A census could not be applied in this phase of the current study due to the magnitude of the population, associated costs, and time limitations. The focus was on collecting a sample that would represent the target population.

5.15.3.1 Non-probability sampling

In non-probability sampling, the probability of selection of a sample unit is unknown, unlike probability sampling. There is in fact no rational method to prove that the selected sample represents the population. Due to time and cost restrictions in social sciences research, non-probability sampling is often adopted (Singh, 2007:107). As the population size was millions, no lists were available, and a sample frame could not be obtained, therefore non-probability sampling technique was employed.

5.15.3.2 Convenience Sampling

Different non-probability sampling techniques exist. It would be preferable if the entire population could be tested in all forms of research, but in many scenarios, the population is so large not every individual can be included. For this reason, most researchers rely on the most common sampling technique, namely convenience sampling; it is a relatively easy, fast, and inexpensive method of collection data (Explorable, 2009).

The disadvantage of convenience sampling is that subjects are selected who are more accessible and all qualified individuals in the target population do not have an equal opportunity to be part of the study. Results of a study are not necessarily generalisable to the population, but if the sample size increases, there is an increase in statistical power of the convenience sample (Etikan, Musa & Alkassim, 2016:4).

The population in this study was the majority of the adult persons in South Africa, as almost everyone uses electrical and electronic equipment which eventually comes to an EoL stage. It is evident that convenience sampling would be a sound choice as almost all respondents would fit the requirement of being an e-waste consumer.

5.15.4 Sample size

To ensure that factor analysis can be done with confidence, a sample size of at least 300 is required (Tabachnick & Fidell, 2007:613). Data analysed using SEM generally requires large samples of more than 500 respondents (Pallant, 2011:104). For the quantitative phase of this study, 6586 questionnaires were sent out by the research firm to individuals on the database who fit the criteria. Five hundred and twenty two valid surveys were returned, so the response rate was 8%. Of the 6586 e-mails distributed to persons fitting the criteria, 646 visited the survey site and 522 completed the survey. The completion rate was thus 81%. The sample size of 522 was adequate to ensure statistically reliable results. This relative large sample size allowed for factor analysis and structural equation modelling (SEM) to be conducted.

The sample size of the current study is also aligned with past surveys using the TPB model to determine consumers' e-waste recycling behaviour intentions in developing markets. Echegaray and Hansstein (2017:5) surveyed 806 Brazilian consumers, Nguyen *et al.*, (2018:12) received responses from 520 Vietnamese consumers and Zhong and Huang (2016:477) relied on a sample of 662 to determine consumers' willingness to participate in e-waste recycling in China.

5.15.5 The sampling element

The sampling element, of a study, is a single respondent from the target population who can give the information the researcher requires, and which can be used to make conclusions (Malhotra & Birks, 2007:406). The sampling element in this study was an adult respondent older than 18 years, who resides in urban areas of South Africa and completed the online questionnaire.

5.15.6 Surveys errors

According to Curwin and Slater (2004:276-277), one can never be sure they have the right answers. This is due to two types of errors, which could have an effect on the outcome, sampling error and non-sampling error.

5.15.6.1 Sampling error

Sampling errors refers to small variations, which will occur every time a new sample of the population is taken. It is thus the difference between the sample statistics and the estimated results for the population. A proper sample design and a large sample size can help to reduce sampling errors (Curwin & Slater, 2004:276; Singh, 2007:109). The sample design and relative large sample of this study helped to minimise the sampling error.

5.15.6.2 Non-sampling error

Non-sampling errors can be caused by human errors, where the researcher did not define the problem and objectives clearly, poor sampling, faults in the measurement instrument design and non-responses (Curwin & Slater, 2004:276; Singh, 2007:109).

To address non-sampling errors, the researcher adapted the research instrument from other studies. Pilot testing was done by involving the co-supervisor and the statistician as both had extensive experience in questionnaire design.

Care was taken to ensure the questions in the instrument were easily understandable and that questions would not confuse respondents. The questionnaire could be answered in less than 10 minutes, which contributed to a higher response rate.

5.16 DATA-COLLECTION

5.16.1 The data-collection instrument

A questionnaire must have unambiguous and clear questions with categories that are carefully chosen (Barnett, 1991:71). It forms the basis of data collection and is the tool of data collection. It is useful and good practice, if researchers can modify and use questions from other tested questionnaires (Curwin & Slater, 2004:270). In line with this approach, constructs were used from existing studies, which went through rigorous processes culminating in being part of nationally accredited publications.

5.16.2 The research instrument layout and content

A proper developed questionnaire shows professionalism, contributes to the collection of reliable, accurate and valid data, increases the response rate of a survey, limits response error and adds the credibility of the research (McGivern, 2013:275). Annexure F represents the structured questionnaire used in the online survey of this study. The online survey had the following sections:

- ***Introduction of survey***

The survey started with a short introduction stating that the study was undertaken by the researcher from the North West University. It then briefly explained what e-waste entailed and defined e-waste recycling. It was also explained that the questionnaire would take around 10 minutes to complete, and that the respondents would remain anonymous and their personal responses would be confidential.

The survey could only be accessed through a link and no personal information was required, such as names, addresses or contact numbers, which added to the anonymous and confidential nature of the study.

- ***Constructs measurements***

In Annexure F, the different constructs in the questions are presented. The structured questionnaire consisted of different sections from A to K with the nine constructs and a section on demographical information:

- A) *Environmental awareness* refers to support or active work toward the protection of the natural environment from destruction or pollution (American Heritage Dictionary, 2011).
- B) *Attitude towards e-waste recycling* refers to the environmental cognition of respondents to recycle e-waste (Wang, Guo & Wang, 2016:852).
- C) *Norms and publicity* (also called subjective norms) refers to laws, regulations, and media-related propaganda informing respondents about e-waste recycling (Wang, Guo & Wang, 2016:852).
- D) *Cost of recycling* refers to perceived costs of recycling and not the real costs allocated to recycling, and includes perceived time spent on recycling (Wang, Guo & Wang, 2016:852).
- E) *Convenience of recycling* refers to respondent's perceptions of processes to formally recycle e-waste (Wang, Guo & Wang, 2016:852).
- F) *Behavioural intention* refers to the willingness and behaviour of respondents towards recycling e-waste through formal recycling channels (Wang, Guo & Wang, 2016:852).
- G) *Awareness and attitude towards a points rewards system*. This construct is testing the familiarity with PRS and the participation in PRS, which respondents presently have.

- H) *Willingness to participate in e-waste recycling with points rewards system*. This construct refers to the willingness to participate, which respondents would if rewards were to be linked to e-waste recycling (Zhong & Huang, 2016:477).
- I) *Accountability to recycle e-waste*. This construct is testing the willingness of respondents to pay a fee for recycling of e-waste. It further investigates the perceptions of respondents who should be taking responsibility to recycle e-waste (Yin, Gao & Xu, 2014:523).
- J) *Current behaviour/past disposal practices*. The construct is testing the current disposal practices employed by consumers of e-waste. An array of disposal practices were included in the construct to test for all possible disposal scenarios (Echegaray & Hansstein, 2017:184).
- K) *Demographic information*. Respondents were asked to complete the demographic section, which requested the respondents' age, gender, city of residence, income, education level, and the home language. Respondents were recruited by a professional research firm with a large database across South Africa. One requirement was that respondents had to be 18 years or older and the questionnaire only allowed such people to be selected. A screening question was not used, but the measures taken would probably ensure that only adult respondents participated.

The items in each of these constructs, the original reported Cronbach's Alpha values, and the sources from where they were obtained and adapted are indicated in the following table:

Table 5.5: Items and reliability for constructs A to F included in the questionnaire

	Item statement	Original Cronbach's Alpha	Source
A)	Environmental awareness (EA)	$\alpha=0.751$	Wang, Guo & Wang (2016:859)
EA1	I am often concerned about environmental issues		
EA2	I think that our daily habits can affect the environment.		
EA3	I think everyone should contribute to protect the environment.		
B)	Attitude towards e-waste recycling (ATR)	$\alpha=0.914$	Zhong & Huang (2016:479)
ATR1	I believe that recycling of e-waste can reduce environmental pollution.		
ATR2	I believe that informal recycling of e-waste can pollute the environment.		
ATR3	I believe that recycling of e-waste can protect the use of natural resources.		
ATR4	I would like to contribute to the reduction of harmful e-waste.		
ATR5	I believe that all households should voluntarily participate in e-waste recycling.		
ATR6	I support initiatives that aim to set up an organised e-waste collection system.		
ATR7	I support initiatives that aim to set up an organised e-waste recycling system.		
C)	Norms and publicity (NP)	$\alpha=0.882$	Zhong & Huang (2016:479)
NP1	There are sufficient laws and regulations governing e-waste recycling in South Africa.		
NP2	The media publishes enough information on formal e-waste recycling.		
NP3	The media publishes relevant information on formal e-waste recycling.		
NP4	The people around me participate in formal e-waste recycling.	$\alpha=0.862$	Zhong & Huang (2016:479)
D)	Cost of recycling (CoR)		
CoR1	Travelling costs to dispose e-waste are high.		
CoR2	The time spent by me to dispose e-waste is high.		
CoR3	The compensation for returning e-waste is too small to be worthwhile.	$\alpha=0.696$	Wang, Guo & Wang (2016:859)
CoR4	The handling charges for e-waste recycling will be high.		
E)	Convenience of recycling (ConR)		
ConR1	I have time to deliver e-waste to a collection point.		
ConR2	I have transport to take large e-waste (fridge, stove, etc.) to a collection point.		
ConR3	I can take small e-waste (kettle, toaster, radio, etc.) to a collection point.		
ConR4	I think recycling channels in my neighbourhood are adequate.	$\alpha=0.61$	Wang, Guo & Wang (2016:859)
ConR5	I think recycling channels in my neighbourhood are close enough to my residence.		
F)	Behavioural intention (BI)		
BI1	I am willing to spend time to take my old electronic appliances to collection points.		
BI2	I am willing to speak to my friends about appropriate methods for disposal of e-waste.		
BI3	I am willing to get more information about appropriate methods to dispose e-waste.		

Table 5.6: Items and reliability for constructs F to J included in the questionnaire

G)	Awareness and attitude towards a points rewards system (AAT-PRS)					Not applicable	Zhong & Huang (2016:479)
AAT-PRS1	Are you aware of current Points Rewards Systems? Examples are E-Bucks, U-count awards, Pick n Pay rewards, ABSA rewards, etc.?						
AAT-PRS2	Are you currently participating in any form of Points Rewards Systems?						
H)	Willingness to participate in e-waste recycling with points rewards system (WP-PRS)					Not available	Zhong & Huang (2016:479)
WP-PRS1	I would be willing to participate in an organised e-waste recycling system, which uses a PRS.						
WP-PRS2	An organised e-waste recycling system, which uses a PRS would make me aware of my own carbon footprint.						
WP-PRS3	The number of points awarded when I return e-waste would be important to me.						
WP-PRS4	The type of products/services awarded when I return e-waste would be important to me.						
I)	Accountability to recycle e-waste (AR)					Not available	Yin, Gao & Xu (2014:516)
AR1	I believe that the government should be responsible to recycle e-waste.						
AR2	I believe that the manufacturer/importer of the electrical or electronic product should be responsible to recycle e-waste						
AR3	I believe that the seller/retailer of the electrical or electronic product should be responsible to recycle e-waste.						
AR4	I believe that the consumer of the electrical or electronic product should be responsible to recycle e-waste.						
AR5	I believe that the municipalities should be responsible to recycle e-waste.						
	Willingness to participate in the payment of a recycling fee						
AR6	I believe that the payment of a recycling fee should be part of the product price when the product is purchased.						
AR7	I believe that the payment of a recycling fee should be collected when the product is disposed.						
AR8	I am willing to pay for a part of the costs to recycle my e-waste.						
AR9	If consumers have to pay part of the recycling costs for e-waste, what percentage of the selling price will be acceptable to you? Mark ONE.						
	0 to 6%	7 to 12%	13 to 18%	19 to 25%	more than 25%		
J)	Current behaviour /past disposal habits (D)					Not available	Echegaray & Hansstein (2017:188)
	How do you typically deal with your households' e-waste? (Mark ALL applicable options)						
D1	Dispose with ordinary garbage.						
D2	Dispose along with separated waste (If you separate your organics and recyclables)						
D3	Dispose of it at a collection point specific for electronic-waste						
D4	Take it to a specific collection point as indicated by the manufacturer						
D5	Return to the store where I purchased it						
D6	Donated it to a charity institution						
D7	Give it to other people who could use it or repair it for themselves.						
D8	Store it at my residence.						
	Other						

- **Measurement scales**

A researcher must create a method of assessment, which can deliver numerical values and which represents perceptions and intentions. The four scales of numerical measurements are as follows:

- Nominal scales do not inherently have numbers and if a number is assigned to a value, the one does not have a higher value compared to the other. Gender, race, colour preferences would fall into this category, as one can only count these variables (Scherbaum & Shockley, 2015:22; Singh, 2007:73).
- Ordinal scales capture rank order. The distance between the values are not fixed. Excellent, average and poor are examples of the ranking where the difference between the values is not known (Singh, 2007:74).
- Interval scales allows one to rank items but also to quantify the size of the difference between the items. The difference between two measurement units is the same. The experiences, characteristics, and opinions of persons are normally ranked using an interval scale (Scherbaum & Shockley, 2015:23; Singh, 2007:74). The majority of the constructs were ranked in this study using the interval scale.
- Ratio scales include a true zero and there is a constant distance between any two units (Scherbaum & Shockley, 2015:23).

Table 5.7: Questions, constructs, measurement scales, and -levels

Question/s		Construct	Measurement scales	Level of measurement
Q1-Q3	A	<i>Environmental awareness</i>	Likert scale	Interval
Q4-Q10	B	<i>Attitude towards e-waste recycling</i>	Likert scale	Interval
Q11-Q14	C	<i>Norms and publicity</i>	Likert scale	Interval
Q15-Q18	D	<i>Cost of recycling</i>	Likert scale	Interval
Q19-Q23	E	<i>Convenience of recycling</i>	Likert scale	Interval
Q24-Q26	F	<i>Behavioural intention</i>	Likert scale	Interval
Q27-Q28	G	<i>Awareness and attitude towards a points rewards system</i>	Dichotomous scale	Nominal
Q29-Q32	H	<i>Willingness to participate in e-waste recycling with points rewards system</i>	Likert scale	Interval
Q33-Q36	I	<i>Accountability to recycle e-waste (Imbedded was a willingness to participate in the payment of a recycling fee)</i>	Likert scale	Interval
Q37		<i>Recycling fee percentage</i>	Categorical	Ordinal
Q38	J	<i>Current behaviour/past disposal practices</i>	9 multiple choice items – multiple response scale	Nominal
	K	<i>Demographic variables</i>		
Q39		<i>Gender</i>	Dichotomous scale	Nominal
Q40		<i>Age</i>	Categorical	Ordinal
Q41		City of residence	6 multiple choice items - single response scale	Nominal
Q42		Monthly income	8 multiple choice items - single response scale	Nominal
Q43		Education level	6 multiple choice items - single response scale	Nominal
Q44		Home language	12 multiple choice items - single response scale	Nominal

Table 5.7 shows the measurement scale and levels used in the study. The Likert scale was used in the majority of the constructs to measure the extent to which respondents agreed or disagreed with the construct questions. The five point Likert scale was divided into 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree. Likert scale were used to measure environmental awareness, attitude towards e-waste recycling, norms and publicity, cost of recycling, convenience of recycling, behavioural intention, willingness to participate in e-waste recycling with point's rewards system, and accountability to recycle e-waste.

Willingness to participate in the payment of a recycling fee used an ordinal scale, which provided respondents options of the percentages they would be willing to pay as a recycling fee.

The current behaviour was tested by allowing respondents to choose between ten different options. Demographic variables was measured using nominal scales.

5.16.3 Reliability and Validity

Validity and reliability are not synonyms in statistical applications. Questionnaire responses are imperfect and measurement errors can occur (Singh, 2007:76-77). It is thus be important to ensure reliable and valid results as the constructs used were from international studies. These studies were conducted on residents with different social and cultural backgrounds.

5.16.3.1 Reliability

Reliability is concerned about consistent measurement, thus getting the same outcome every time it is used (Singh, 2007:77; Walter, 2006:12). McGivern (2013:228) asserts that reliability is when a low degree, or no degree, of error exists when measuring constructs, thus contributing to consistent results. To assess the reliability and internal consistency, Cronbach's alpha reliability measurements is one of the most frequently used (Malhotra & Birks, 2007:358; Singh, 2007:78). This reliability measurement was adopted in analysing the data from the study using the SPSS statistical analysis software. The Cronbach alpha values range from 0 to 1, where values closer to 1 indicate greater reliability (Pallant, 2011:6). Cronbach alpha values of below 0.7 can be expected and allowed because there are a variety of constructs being tested when researchers deal with psychological constructs (Field, 2009:675). When there are less than 10 constructs, in this instance there was 10, it is common for Cronbach alpha values to go as low as 0.5, and still be acceptable (Pallant, 2011:97).

In this research, two constructs having Cronbach Alpha's of close to 0.6 were included in the development of the measuring instrument, as it was deemed acceptable.

5.16.3.2 Validity

Validity is concerned about measuring that for which it was designed. Singh (2007:77) warns researchers that a measurement can be reliable, thus giving the same results every time, but not valid. To avoid this, the most appropriate research design is needed for a study. The following sub-categories of internal validity exist:

i) Face validity

Face validity is the least sophisticated measure of validity and simply assesses whether an instrument appears, at face value, to measure what it claims to (Singh, 2007:79). A direct measurement of face validity was obtained by asking colleagues and friends to assess the validity of a test as it appeared to them.

ii) Content validity

According to Singh (2007:79), content validity is assessed by doing a systematic and subjective assessment of how well the content of a scale adequately covers what it is supposed to measure. Researchers must ensure they measured the concepts they intended to measure. Other knowledgeable researchers or people can be consulted to ensure that the measure captures the concept.

The researcher did an extensive literature review to determine how the relevant concepts were measured in a developing context; a supervisor also monitored the process to ensure face validity. This helped to identify the items of the construct included in the questionnaire of the current study.

iii) Construct validity

Construct validity requires researchers to deduce hypotheses from relevant theory. There must be a logical relationship between the different variables, which is measured. This involves theoretical expectations about relationships between the core variable and the rest (Babbie & Mouton, 2001:123). Theory dictates the design of a test and a construct is valid if the results from the test correlate with this theory (McGivern, 2013:227).

By carefully studying the TPB and international research on the topic (e.g. Garlapati, 2016; Khan *et al.*, 2014; Lepawsky, 2012; Nnorom & Osibanjo, 2008; Oliveira, Bernardes & Gerbase, 2012; Ongondo, Williams & Cherrett, 2011; Salhofer *et al.*, 2016; Sthiannopkao & Wong, 2013; Torretta *et al.*, 2013; Zeng *et al.*, 2013) the researcher ensured construct validity was achieved.

Relevant and existing constructs, which had statistical significance, were identified and used in the South African study. Reliability tests were done during the pilot test as well as during the final analysis. The constructs were then analysed to determine relationships between them for hypotheses testing, thus ensuring construct validity.

5.17 PREPARATION AND COLLECTION OF DATA

The conclusions that will be drawn and the chosen quantitative analysis methods depend on the data to be collected (Scherbaum & Shockley, 2015:44). It is of utmost importance to make sure that the questions in the research instrument are clear to respondents and if there are any that they refuse to answer, this must be highlighted (Patten & Newhart, 2018:110).

5.17.1 Pilot study

Before a researcher commits time and money to do a full-scale data collection, it is essential to do a pilot test with the questionnaire (McGivern, 2013:314).

The researcher did a pilot test using the questionnaire that was developed at the time. E-waste was collected on a specific day and the researcher arranged with the organisers of the event to distribute the questionnaire for the pilot test.

In the final analysis, the construct with the questions proved to be reliable. This final questionnaire was used to collect data.

The pilot test shared light on the time duration to complete the questionnaire (7 to 10 Minutes). Pilot test respondents were 18 years and above, living in Pretoria (urban area) and active users of electrical equipment.

The respondents thus represented a sample of the population to be tested. The data collected from 43 respondents were statistically tested. It revealed that the correct data were captured and could be used to test the specific hypotheses. Discussions with the respondents of the pilot test revealed they understood the items in the questionnaire.

The questionnaire was supplied to a research firm for online distribution to urban respondents. Before implementation, the researcher reviewed the first draft of the online questionnaire and scrutinised it for errors. Minor mistakes were found and after the second draft, the questionnaire was ready to be distributed. As a final precaution, the researcher contacted 10 of his work colleagues, which also conformed to the requirements of the population. The online survey was completed by the colleagues, followed by a discussion with the researcher. Again, the colleagues confirmed the timeframe of between 7 and 10 minutes to complete the survey and the understandable nature of the questionnaire. Consequently, the survey could be conducted, as the measuring instrument was error free and ready for distribution.

5.17.2 Ethical issues

Ethical issues in research is concerned with matters of right and wrong where people and animals are concerned (Patten & Newhart, 2018:32). Ethical clearance was obtained by the researcher from the Ethics Committee, Engineering, of the North West University, on the 27th March 2017. The measures taken to ensure ethical conduct in the process were:

- The pilot test and supervisor involvement ensured there were no leading or inappropriate questions, ensuring that data collection was unbiased and ethical.
- During the pilot test, as well as the online survey, the researcher ensured that respondents gave consent to be part of the study. A hard copy was signed by respondents during the pilot test and the online survey requested consent to continue with the survey. The online survey also informed respondents of the purpose of the study. Participants could withdraw at any moment and they were not forced to answer a question before moving to the next one. This resulted in a few (+/-10) respondents who did not answer some questions, a low number compared to the overall response of 522.

- The researcher did not have contact with any of the respondents in the collection of the data as it was done online. Anonymity and confidentiality were guaranteed in the consent form, which accompanied the survey. Without any contact with respondents and the data being collected online, this promise could be kept.
- Items in the constructs were easy to understand, which ensured a short period (7 to 10 minutes) in which respondents completed the survey. This ensured there was no respondent fatigue, or respondents dropping out of the study.

5.17.3 Procedure of data collection

The quantitative nature of this phase of the research required the data to be mainly collected in a numerical format. Due to the size and nature of the study, the researcher required data from urban consumers from large cities.

The questionnaire was developed as described and given to a research firm for online distribution. The criteria of what the sample should look like was given to the research firm, which distributed the questionnaire and the required sample was collected. The research firm employed an online format, which was easily accessible and understandable. The research firm has a large database of residents in urban areas across South Africa. The required profile of the sample guided distribution to the correct respondents. The respondents were not compensated and the researcher had to fund the operation. No influence was exerted to obtain their co-operation. The respondents received an e-mail from the research firm containing a hyperlink to the online survey. On accessing the link the respondents were informed of the aim of the study, which is to determine which factors are drivers and inhibitors of effective e-waste recycling.

5.17.4 Response rate

It is suggested that a number of at least 300 cases/respondents is needed to conduct factor analysis (Tabachnick & Fidell, 2007:613). The final sample collected was 522, which was more than adequate to do factor analysis and statistical analysis.

5.18 PREPARING AND PROCESSING DATA

For statistical analysis, the data must be in an appropriate format. The quality of the statistical outcomes will be affected if this is not done properly. The next sections discuss the steps to prepare and process the data.

5.18.1 Capturing of the data

All the respondents received an e-mail with a link directing them to the survey. On completion of the survey, the respondents had to click on the “submit” button. The completed responses were then captured into a database. Five hundred and twenty two accurately completed questionnaires were received. The researcher received the data from the research firm in a Microsoft Excel format, which was then imported to the statistical software SPSS. Capturing of data was done by the firm, which ensured that data was not lost.

5.18.2 Editing of data

According to Malhotra and Birks (2017:477), data editing is the process to inspect the data from the questionnaires for errors and incompleteness. Respondents were allowed to skip questions in the survey. This was done to ensure the ethical integrity of the survey if respondents did not feel comfortable with questions, e.g. earnings. Questions that were not answered were however minimal. In the current behaviour section there was an option of “other,” which referred to other options than the disposal methods given in the survey. This could be interpreted as an open-ended question. Only three responses were received at the disposal methods given as “other” by the respondents. The disposal methods but could be incorporated into the given options which was done by the researcher, effectively changing this question into a closed-ended question. The SPSS software thus only had the eight possible disposal options in the analysis. The editing of an online survey is limited and the researcher could only make this minor change.

5.18.3 Coding data

Coding is the process of classifying research data into categories (numbers) for the purpose of data analysis (Singh, 2007:82). In this study, gender was coded as male = 1, and female = 2. Similarly the awareness of a point rewards system was coded as Yes = 1, and No = 2. The data was ready for analysis at this stage. The majority of the questions used the Likert scale and the coding of 1 to 5 was assigned from “Strongly disagree” (1) to “Strongly agree” (5), as they were closed-ended questions. The constructs had only positive loadings and reverse coding was not needed.

5.19 ANALYSIS OF THE DATA

Data on its own is meaningless, but when analysis using statistical techniques takes place, the data can be transformed into useable information. Statistical methods can be broadly classified into two categories, 1) descriptive statistics, and 2) inferential statistics (Singh, 2007:122-125).

5.19.1 Descriptive statistics

Descriptive statistics is the analysis of variables, which can then be described by the researcher (McGivern, 2013:455). Descriptive statistics summarise, describe and explain data sets. The discussion of this section is based on Singh (2007:124-155), which explains the need and uses of different analysis methods. In this study, figures and tables were used to display frequency distributions, which is a display of the frequency or percentages of occurrence of an event.

5.19.1.1 Measures of central tendency

The measures of central tendency provide the researcher with information about central points of a distribution. The mean value is an average value and the most commonly used central tendency measure (Singh, 2007:136). It is calculated by adding the sample responses and dividing it by the number of responses received (McGivern, 2013:462). Mean values were calculated and included in tables in Chapter 7, the statistical analysis chapter.

5.19.1.2 Spread of the distribution

The “Spread of the distribution” or “Measures of variability” refers to the spread of dispersion and is another essential measurement in the study. For interval or ratio measurements, the standard deviation (SD) provides the best measure of dispersion (Singh, 2007:144). Standard deviations were included in the tables in Chapter 7, the analysis chapter.

5.19.2 Inferential statistics

In inferential statistics, the researcher uses methods to predict the nature of a population by using the characteristics from a sample. A confidence level is used to generalise from the sample to the population (Singh, 2007:151).

5.19.2.1 The effect of biographical variables on the factors

Three different types of test have been conducted to measure the effects of biographical variables on factors, the T-tests, the ANOVA tests, and the Spearman’s rank order correlation.

- **T-test**

An independent-samples t-test is used to compare the mean score, on some continuous variable, for two different groups of participants, i.e. whether males and females differ significantly in terms of the different factors generated from the questionnaire. In statistical terms, one is testing the probability that the two sets of scores (for males and females) came from the same population. If the Sigma (two-tailed) value, or p value, is >0.05 , the conclusion is there is *not* a statistically significant difference in the mean scores of the factor for males and females, if the p value is <0.05 then there is a statistically significant difference (Pallant, 2011:239-240).

- ***An analysis of variance (ANOVA) test***

The ANOVA test is used when comparing the mean scores of more than two groups. For this research, the groups consisted of respondents speaking different languages in South Africa. ANOVA tests compare the variance (variability in scores) between the different languages with the variability within each of the groups (believed to be due to chance). In this situation a one-way ANOVA is used, which involves one grouping variable that has a number of different levels. Post-hoc tests need to be conducted to indicate which of the groups differ (Pallant, 2011:249).

- ***Correlation***

Correlation is one of the frequent measures used to determine associations between two or more variables. It is testing whether an increase in one variable has an increase in another variable. Correlation coefficient (r) is between -1 and +1, where a 0 indicates no correlation. The closer the value is to -1 or +1, the stronger the relationship (Singh, 2007:146). The Spearman's rank order correlation is used on ordinal data when the strength of the relationship between two continuous variables needs to be explored (Pallant, 2011:103). Demographical groups were compared with ordinal data. The Spearman's rank order correlation was used in this study to determine the relationship between the demographic variables (age, monthly income, and education) with the different factors being used. The Spearman's two-tailed Sigma tests were used to determine the correlation coefficient between the different factors in the study. The correlation between the Behaviour Intent and the different factors were the indicators against which the hypotheses were accepted or rejected.

5.19.2.2 Hypothesis testing

Hypothesis testing is one of the most often used techniques provided to accept or reject a hypothesis that was formulated by a researcher. A hypothesis is an assumption, which was made by a researcher about a parameter from the population and will be accepted or rejected by the tests (Singh, 2007:155). In this study, the SEM and correlations were used to test the hypotheses, which are listed in Table 5.8.

Table 5.8: Proposed research hypotheses

Hypotheses
H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.
H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.
H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.
H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.
H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.
H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.
H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.
H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.
H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

5.19.2.3 Level of Significance and accepting or rejection of hypotheses

A null hypothesis is one that assumes there is no statistical differences between two measured phenomena or means. The level of significance refers to the probability to which a researcher is willing to reject or accept a null hypothesis when in fact it is true (Singh, 2007:155). The *p*-value is the criteria for statistical significance of tests (e.g. t-tests) and used to show if there are a statistical significant difference between means for example. A value of $p < 0.05$ is normally the standard. The smaller the *p*-value, the better, as that will indicate the alternative hypothesis can be accepted and the chances of making a mistake are small (Ellis & Steyn, 2003:51; Pallant, 2011:239-240). This implies there is a 5% possibility that the results occurred purely by chance, and this level of significance was used in this study. Significance tests must thus be done to determine whether a hypothesis should be accepted, or rejected (McGivern, 2013:500).

5.20 MULTIVARIATE ANALYSIS

Multivariate analysis is a statistical method that can conduct analysis between three or more variables simultaneously (Singh, 2007:177).

5.20.1 Factor analysis

According to McGivern (2013:494), the purpose of factor analysis is to combine original variables to produce a new set of factors, which will assist in interpreting new patterns and relationships. This could happen if more than one factor is measuring the same principle (Singh, 2007:202).

5.20.2 Principal Component Analysis (PCA)

Principal Components Analysis (PCA) re-expresses data into components and is a data reduction system; it still incorporates as much data as possible (Singh, 2007:203). The PCA method with Oblimin rotation was used in the study. This technique attempted to produce a smaller number of linear combinations of the original variables in a way that captured (or accounted for) most of the variability in the pattern of correlations. SPSS software generated two statistical measures to help assess the factorability of the data. The first was the Bartlett's test of sphericity (Bartlett, 1954:297). For this test to be significant, the p value must be smaller than 0.05. The second measure was the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser 1970, 1974). The KMO index ranges from 0 to 1, and for this test to be significant it is suggested that the KMO value should be at least 0.6 for a good factor analysis (Tabachnick & Fidell 2007:639); a minimum of 0.5 was recommended (Kaiser, 1974:36).

5.20.3 Structural equation modelling (SEM)

SEM is a sophisticated technique, which allows researchers to test different models regarding the interrelationships among a set of variables. It allows one to test the overall fit of the model to the data by evaluating the significance of each of the independent variables in the model. This is based on factor analysis and multiple regression techniques. It also allows one to compare alternative models (Pallant, 2011:104-105). According to Singh (2007:221), SEM analysis can simultaneously test the dependence relationships between variables. In the statistical analysis chapter, Chapter 7, it will be demonstrated that even when there is a statistically significant relationship between variables, the use of SEM produces a better fit, and thus a more refined model.

5.21 MEASUREMENT MODEL

A measurement model is a graphical representation of the conceptual framework, as developed in Chapter 4. It displays the developed relationships between the constructs in the study and the independent. Figure 5.4 shows the conceptual framework for the quantitative phase of the study.

Figure 5.4: Graphical representation of the conceptual framework

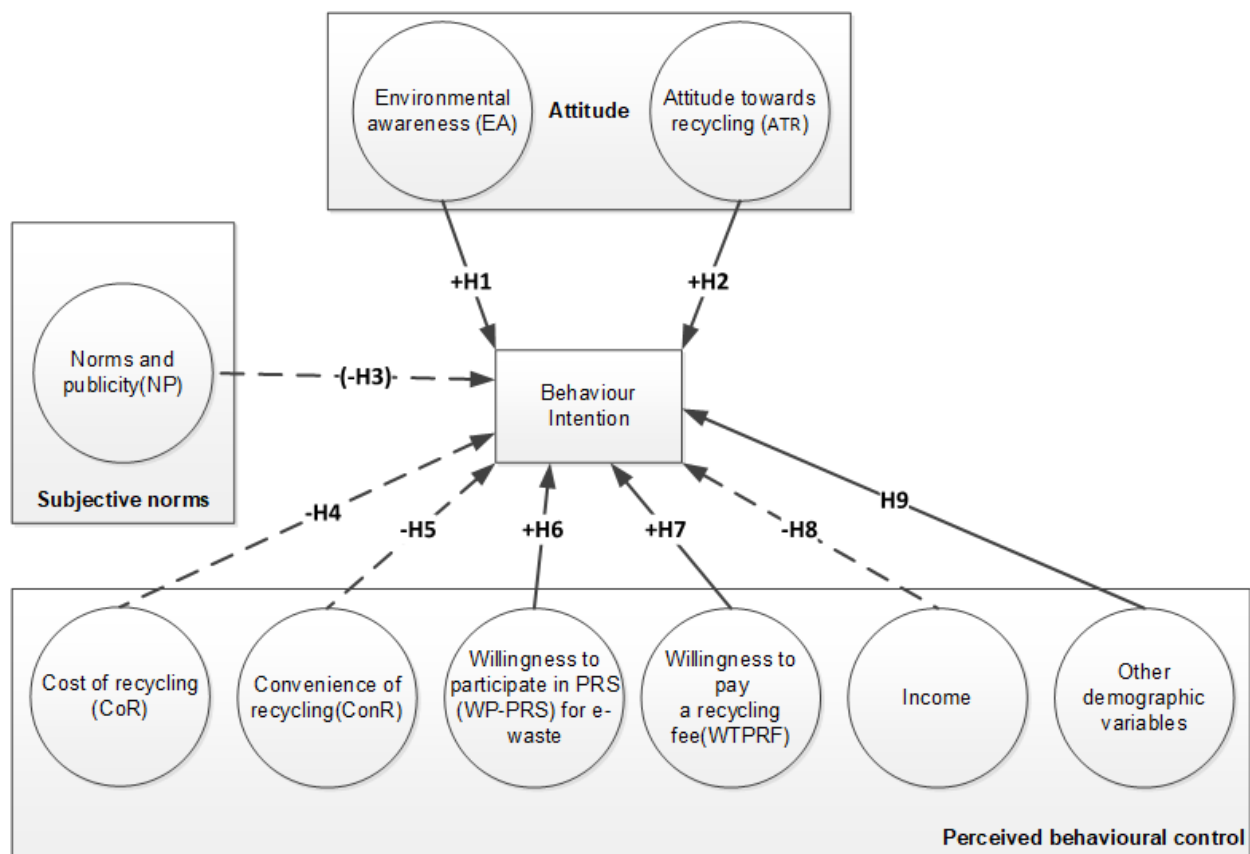


Figure 5.4 indicates the links between the constructs and the nature (Positive or negative) of the developed hypotheses. Solid lines indicate a positive relationship while the broken lines indicate a negative relationship between constructs. The hypotheses were derived from previous research and the application of the TPB model (see Chapter 4). *H1* for example, proposes that environmental awareness positively affects e-waste recycling behaviour intentions, and this is supported by past research findings.

5.22 CONCLUSION REGARDING QUANTITATIVE RESEARCH PHASE

This chapter started with a short overview of what a mixed methods research study entails. A short discussion of the convergent parallel design was given, together with a graphical representation. As the qualitative and quantitative strands were done independently in the convergent design, the methodologies were also discussed separately. A discussion of the qualitative phase of the research was followed by a discussion of the quantitative phase. In the discussion of the qualitative phase, the research design, the selection of participants, the interview guide development and the data collection method were discussed. How the data was analysed and reported were discussed, as well as how the quality of the enquiry was evaluated. A description of how ethical clearance was obtained, and the ethical principles followed throughout the process conclude the discussion of the qualitative phase.

A discussion of the quantitative phase of the research design was discussed followed by the sample design. The development of the research instrument and the measurement scales being used in the instrument were presented. The discussion was concluded by indicating how the data were collected, processed and analysed to finally accept or reject hypotheses.

5.23 INTEGRATION PHASE

5.23.1 Integration objective

The objective of the integration is to advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) should be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South-Africa (qualitative results).

5.23.2 Integration strategy

Combining quantitative and qualitative research in the current study guided the development of a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in the South African context.

The rationale for integration in the current study was to compare the data sets in order to determine which measures could be suggested for implementation (from the qualitative phase) to address personal convenience, attitude towards e-waste recycling, and environmental awareness of consumers towards disposal of e-waste (the quantitative phase). Integration at the interpretation and reporting level for the current study was by done by creating joint displays.

5.24 CONCLUSION

In Chapter 5 the research problem, aim, and objectives were given. The need and rationale for using a convergent-mixed methods design was explained. This was followed with a detailed discussion of the qualitative methodology, and how the interviews that were conducted would be analysed. The methodology of the quantitative phase was discussed and how the data from respondents would be analysed. The chapter concluded with a short description of how the qualitative and quantitative data would be integrated. In Chapter 6, the qualitative data will be analysed and reported, in Chapter 7 the analysis and reporting of the quantitative data will be discussed, and in Chapter 8 the analysis and reporting of the mixing of the two strands will be presented.

CHAPTER 6: QUALITATIVE FINDINGS AND DISCUSSION

6.1 INTRODUCTION

This chapter starts with a description of the participants who contributed to the research. A short description of each participant's involvement in the research environment is given, followed by an overall graphical layout of the codes, categories and themes developed from the interview transcripts. Atlas.ti was used for the coding and a graphical network presentation of the first theme will be displayed; the remainder of the networks can be seen in Annexure B. The researcher will also give a description, and a graphical layout, where needed, of the proposed future interventions where applicable.

The three research questions addressed through the interviews form the structure in which the findings will be presented. The research questions will be addressed, and the related themes, categories, codes, existing literature, and related theory will be discussed under each of the research questions. In the case of research questions one and two, each is addressed with one theme whereas question three has five themes addressing the question.

6.2 RESEARCHER DESCRIPTION

6.2.1 Background of the researchers

- ***Researcher***

The researcher is working in the higher education system at a university in South Africa. His field of specialisation is in Electronics, with a focus on embedded digital systems. This involves the training of students in programming micro-controllers for industrial applications. He holds Master's degrees in Electrical Engineering (Digital), and Business Administration (MBA). Although he has been involved with the electronic sector his whole career, he only became aware of the detrimental effects of electronic waste after being involved with a project addressing e-waste from one of the cellular networks in South Africa.

The lack of a system to address collection, recycling, refurbishing, and proper disposal of household e-waste prompted him to investigate and research the South African scenario. After reviewing the South African literature on the topic the researcher visited European countries to understand their WEE systems. He was also involved in some informal discussions with consumers, recyclers, environmentalists and refurbishers around South Africa that confirmed the need for the development of a proper framework to manage household e-waste.

To be equipped for the collection and interpretation of the qualitative data the researcher completed courses in interview techniques, analysis of qualitative data, and training on Atlas.ti.

- ***Co-coder***

The co-coder is a registered Research Psychologist who practices as an independent consultant within the field of social sciences. He attained his MA degree in Research Psychology, specialising in research consultation, through the University of South Africa (UNISA). This required extensive training and the development of a vast knowledge in Research Methodologies. The co-coder gained extensive experience within the field of qualitative inquiry, which was gained through more than 5 years of conducting qualitative research in multiple fields or disciplines.

The researcher approached the co-coder in order to conduct a co-coding process for the purposes of ensuring trustworthiness within this particular study at hand. This process required the co-coder to understand the conceptual, contextual, theoretical, and methodological aspects regarding the study and to ensure that a sound understanding of the various components were obtained before the co-coding process could be initialised. After the co-coding process was complete, the co-coder had discussions with the researcher to reach a form of consensus. This helped to ensure consistency and credibility.

6.2.2 Management and potential influence of prior understanding of the topic

The European countries visited make use of EPR, as well as PRO's to manage their e-waste. EPR and PRO structures are different even in the European Union (EU).

Care was taken by the researcher to get the views of specialists on the best way forward and to not use the two principles as the norm. It became clear that specialists in the producer/manufacturer/-importer sector, environmentalists, recyclers/retailer sector, and government structures, had to be interviewed to assist in the development of a household e-waste management framework. It was necessary to get in-depth experiences of professionals in the environment, and interviews were the appropriate method to collect this information. It was also evident that the South African urban consumers had to be surveyed in the study as they were in possession of most of the items causing harm to the environment. The results of this survey will be discussed in the chapter 7.

6.2.3 Relationships and interactions between researchers and participants

During the preliminary South African investigation, informal discussions were held with selected stakeholders. Two environmental specialists and two persons involved in the recycling sector become part of the final study and were interviewed. After the initial contact no further contact was made with these participants, and none of them had any relationship with the researcher or his family members. No ethical issues arose before, during, or after the interviews were conducted with the participants.

6.3 RESEARCH STUDY PARTICIPANTS

6.3.1 Profile of participants

The overall composition of the 20 participants is summarised in Table 6.1 and reviewed below:

Table 6.1: Profile of participants

<i>Identifying code for participant</i>	<i>Participants' position/title</i>	<i>Stake holder group</i>					<i>Gender</i>		<i>transcription pages</i>	<i>Duration of interview (minutes)</i>
		Environmental specialists (ES)	Government authorities (GA)	Recycling/ disposal entities (RDE)	Supply Chain members (SCM)		Male	Female		
P1ES	Managing Director	X					X		40	71
P2ES	CEO	X					X		29	54
P3ES	Working group Co-ordinator	X						X	37	63
P4ES	Waste analyst	X					X		38	69
P5GA	Director-Waste management		X				X		30	56
P6GA	Assistant Manager-Waste management		X				X			56
P7GA	Specialised Environmental officer		X				X			56
P8GA	Deputy Director-Waste management		X				X			56
P9GA	Manager-Waste		X					X	32	43
P10GA	Senior manager & Waste Specialist		X					X	28	45
P11GA	Senior Professional Officer –Collections		X					X	51	73
P12GA	Head-Solid waste minimisation		X					X		73
P13GA	Head-Solid waste collections		X				X			73
P14RDE	Sales manager			X			X		27	43
P15RDE	CEO			X			X		24	37
P16RDE	Internal waste audit manager			X			X		17	26
P17RDE	Managing Director (Notes taken)			X			X		2	30
P18RDE	Operations Manager			X			X		26	43
P19SCM	Manager -African region				X		X		39	63
P20SCM	CEO				X		X		18	53
	Total	4	9	5	2		15	5	438	1083
	%	20	45	25	10		75	25		

- ***Stake holder group representation***

The researcher purposively recruited participants from four key sectors in the e-waste scenario to ensure inclusiveness and expansiveness as a broad range of perspectives and views had to be covered (DePoy & Gilson, 2008:108). Four (20%) of the participants represented environmental specialists, nine (45%) represented government authorities (National [1], provincial [4] and local-government [4]), five (25%) represented recycling/disposal entities and two (10%) participants represented supply chain members.

- ***Gender***

The male participants totalled 15 (75%) and female participants five (25%). The industry seems to be male dominated at the operational level, e.g. recycling and retailing, whereas there is a more representative ratio in the government structures; four of the five females were employed in government structures.

- ***Duration of interviews***

The duration for the interviews was on average 55 minutes, with the shortest being 26 minutes and the longest being 73 minutes. All the interviews together lasted 18 hours and 3 minute.

- ***Combined participants***

Participants 5, 6, 7 and 8 were not interviewed individually and participated in a single interview setting. When the participants gave inputs during the interview, they first mentioned their names to enable the researcher to determine who made comments in the transcripts. Participants 11, 12 and 13 were also interviewed in a single sitting and the individual comments were captured and incorporated in the study. The contributions of all the individuals were clearly captured in the transcripts.

6.3.2 Background of the participants

- ***Participant 1 (Environmental specialist):***

The participant is the managing director of a company that develops technologies aimed at waste beneficiation, e.g. re-using building material. These technologies are used to create jobs in the green economy.

The participant has vast experience in materials recovery (including e-waste), as well as in business and environmental management. The participant is also involved with education and awareness campaigns in the province in which the company operates.

- ***Participant 2 (Environmental specialist):***

The participant is an environmentalist and the CEO of an association that actively pursues initiatives to ensure that e-waste is recycled and managed properly.

- ***Participant 3 (Environmental specialist):***

The participant is also an environmentalist and the co-ordinator of an association that actively pursues initiatives to ensure e-waste is recycled and managed properly. This specialist also has active links with international role players in the e-waste field.

- ***Participant 4 (Environmental specialist):***

This participant is a manager in a non-profit organisation, which works on the development of green economies in South Africa. Their focus is on manufacturing and job creation in the green economy and the organisation supports local, provincial and national government to build a resilient green economy.

- ***Participant 5 (Government authorities):***

This participant is a Director in charge of all solid waste management initiatives in the provincial government.

- ***Participant 6 (Government authorities):***

This participant is an assistant manager involved in the management of all waste types for provincial government, including e-waste.

- ***Participant 7 (Government authorities):***

The participant is an environmental officer for provincial government and his portfolio includes the management of e-waste.

- ***Participant 8 (Government authorities):***

The participant is a deputy director in provincial government, in the planning sector for waste management. E-waste is included in the participants' portfolio.

- ***Participant 9 (Government authorities):***

The participant is a manager in national government and a specialist in the management of all waste types.

- ***Participant 10 (Government authorities):***

The participant is a senior manager in local government and a waste specialist (including e-waste) in one of the biggest cities in South Africa. Waste management in the large cities is extremely challenging compared to small towns.

- ***Participant 11 (Government authorities):***

The participant is working in local government structures for one of the biggest cities in South Africa. This participant is a specialist in the planning of household waste collections, including e-waste.

- ***Participant 12 (Government authorities):***

The participant is also working in local government structures for a large city. This participant is the Head of Solid Waste Minimisation and focuses on all waste types including e-waste.

- ***Participant 13 (Government authorities):***

The participant is also working in local government structures for a large city. This participant is the Head of Solid Waste Collections in the city for all waste types including e-waste.

- ***Participant 14 (Recycling/disposal entities):***

The participant is a manager in one of the largest recycling companies in South Africa. The company mainly disassembles e-waste and sell fractions to local scrap dealers or export it for precious metal extractions. They also do small scale refurbishing.

- ***Participant 15 (Recycling/disposal entities):***

The participant collects e-waste from various entities and then re-sells the e-waste to the bigger e-waste recycling companies.

- ***Participant 16 (Recycling/disposal entities):***

The participant is from the same company as Participant 17, and one of the senior managers involved in business development and internal waste audit in the e-waste scenario.

- ***Participant 17 (Recycling/disposal entities):***

Participant 17 is the MD of one of the largest e-waste recycling companies in South Africa, and an expert in the recycling field. The company also disassembles e-waste in South Africa for local recycling and export fractions for extraction to Europe. The interview was arranged with Participant 16 but was delayed. During this time Participant 17 gave his views on the e-waste scenario and suggestions for the effective management of the waste stream. The researcher made detailed notes of the conversation on the same day and his comments were e-mailed back for verification on the correctness. The participant confirmed that the report was a true version of the discussion and agreed that the notes could be included in the study.

- ***Participant 18 (Recycling/disposal entities):***

The participant is a manager working for a company involved in household solid waste collection and separation. E-waste forms part of the solid waste being collected. Local government is part of the venture and the participant gave valuable input regarding private and public co-operation initiatives.

- ***Participant 19 (Supply Chain member):***

The participant is the sustainability manager for the Africa region, and employed by an international company importing ICT equipment into South Africa. Environmental protection is part of his portfolio and he is actively involved in initiatives in African countries where the producers and governments require e-waste management guidance.

- ***Participant 20 (Supply Chain member):***

The participant is the owner of a company with three branches in three large cities in South Africa. They import and sell household equipment such as fridges, freezers, washing machines, dishwashers, coffee makers, electric stoves, etc. This participant also has a repair shop for faulty equipment repairs at one of the branches. He is knowledgeable about e-waste management in European countries and added valuable insights into how e-waste should be managed in the South African environment.

6.4 PRESENTATION OF THE FINDINGS

The overall findings as they relate to the qualitative research questions, the themes, and categories are presented in Figure 6.1.

Figure 6.1: Research questions with related themes and categories

Research questions	Themes and categories
RQ1a: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste collection from household consumers?	WEEE Collection methods in South Africa •Kerbside placement and disposal of small and large e-waste appliances •Convenience is the key to effective e-waste collection •Authorised mobile e-waste collection •Rural area e-waste collection •E-waste separation stages
RQ1b: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste distribution to recyclers?	Transportation of e-waste •Transport problems and responsibilities
RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?	Extended Producer Responsibility (EPR) •Responsible parties for e-waste management •Creating legislation and awareness on e-waste •EPR Funding •Management of EPR Problem areas regarding recycling infrastructure in South Africa and the role of government to address the recycling needs •Recycling Shortcomings and needs •Government's involvement in addressing e-waste recycling needs Producer Responsibility Organisation (PRO) •PRO Preferences and functions Take back scheme & reward system •E-waste reward system to discourage hoarding •E-waste take back system Proposed Auction house •Arguments for and against auction houses

The seven extracted themes will be discussed, however the reader should keep in mind they are all connected and should be viewed as an integrated view on an e-waste management framework for the South African environment. The themes should not be isolated as they are the experiences, ideas, and suggestions from experts in the field of e-waste and waste in general.

Figure 6.2 is a graphical representation of theme 1 in this discussion. The network is a result of the use of Atlas.ti, and the remainder of the networks themes can be found in Annexure B.

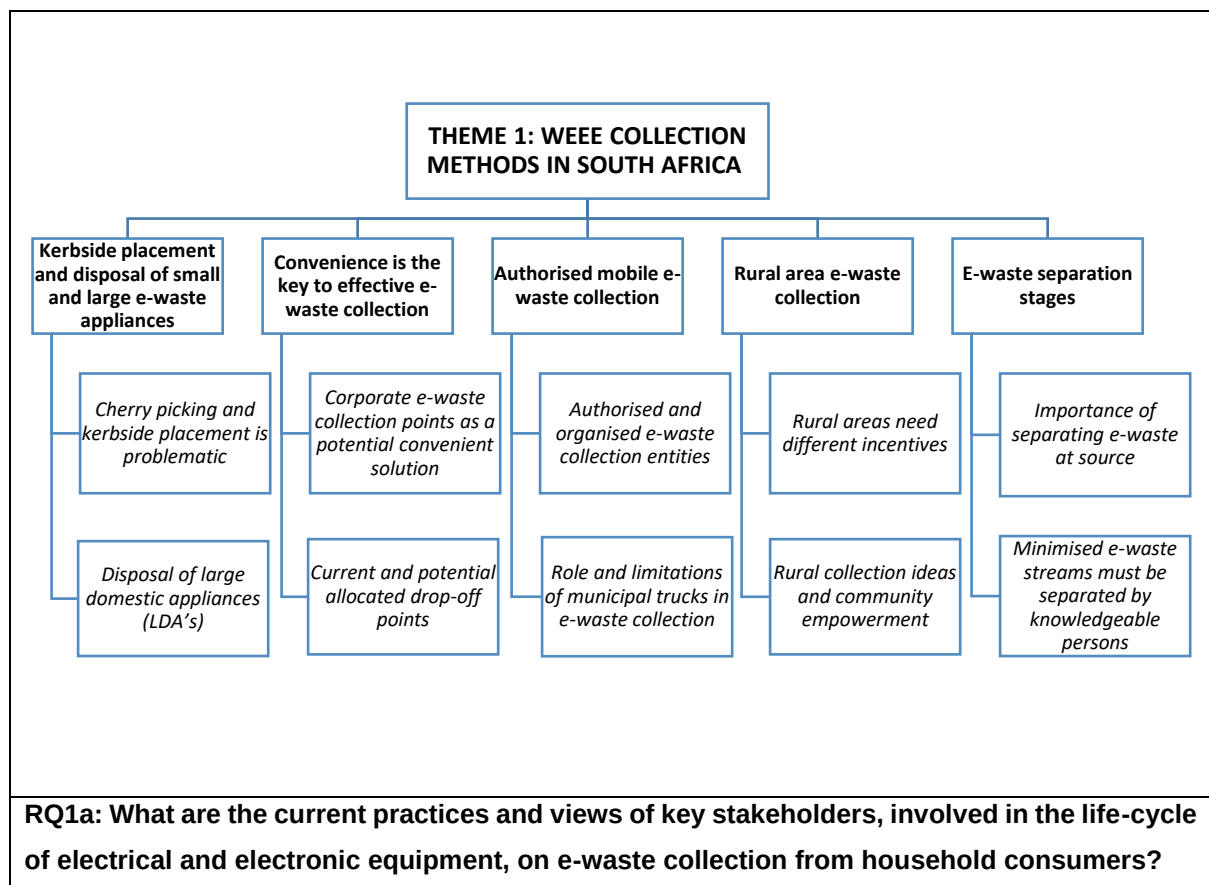
Figure 6.2: Theme 1-WEEE Collection methods in South Africa - Atlas.ti network



6.5 RESEARCH QUESTION 1a AND THEME 1:

It can be seen in Figure 6.3 that theme 1 of the findings addressing research question 1a: ***What are the current practices and views of key stakeholders, involved in the life-cycle of electrical and electronic equipment, on e-waste collection from household consumers?*** The five categories and associated codes included in this theme are interpreted in the following sections.

Figure 6.3: Research question 1a with related themes, categories and codes



6.6 THEME 1: WEEE COLLECTION METHODS IN SOUTH AFRICA

Theme 1: WEEE collection methods in South Africa relates to problems associated with kerbside placement of e-waste, as well as disposal of large domestic appliances (LDA's). It further reflects on the importance of convenience of disposal for consumers and the importance of separating e-waste at the beginning stages. Although not the main focus of the study, some interesting ideas were received on rural e-waste collection.

6.6.1 Kerbside placement and disposal of small and large e-waste appliances

This category relates to two problematic areas experienced with the disposal of small and large e-waste items namely, 1) cherry picking if household e-waste were to be placed on kerbsides and, 2) the problems resulting from transporting large e-waste. These concerns are depicted in the following quotes:

1) *"It's totally unacceptable, ...people putting things on the kerbside, ...because we know that most of the worse practice taking place in South Africa, people burning cables, smashing equipment, that comes from this type of complete uncontrolled release of electronic equipment, waste electronic equipment into the environment."* (P3ES)

2) *"For me personally, I think sometimes these large bulky items is a bit of a nuisance in you as a household, you don't necessarily want a reward for it, you just want it ... you know, taking up space, you bought now your new eye level oven and whatever, and your old stove, you just want it ...to get rid of it."* (P6GA)

- ***Cherry picking and kerbside placement is problematic***

Cherry picking refers to the harvesting of valuable materials from e-waste and dumping the rest. It occurs when consumers dump e-waste on kerbsides or place it next to, or into refuse bins in the hope that it will fall into the right hands.

Two major e-waste-connected risks driving this negative sentiment towards kerbside placement could be distinguished. E-waste-connected environmental- and health-related risks were the most commonly stated reasons identified as to why participants thought kerbside placement should not be allowed.

Several of the participants argued that kerbside placement would result in cherry picking, where only copper and valuable fractions are extracted in a non-environmental, friendly manner (P1ES, P2ES, P5GA, P10GA, P11GA, P14RDE, and P19SCM). Some talked about rudimentary recycling practices that could take place, such as the burning of cables to get rid of Poly-Vinyl Chloride (PVC) in order to sell low grade copper to scrap dealers (P1ES, P3ES, P14RDE, P15RDE, and P19SCM). The participants emphasising the health-related risks warned that e-waste is a potential hazardous waste and placing it on the sidewalk or in rubbish bins could cause leaching of toxic materials at landfills (P1ES, P3ES, and P5GA).

The informal sector, with untrained waste pickers carrying out unsafe and even illegal practices, was the second major e-waste-connected risk driving the stakeholders' negative sentiment. Participants pointed out that waste pickers falsely believe equipment such as computers, toasters, televisions, placed on the kerbside is still in working condition. The equipment is taken to a rural area for fixing but then later dumped after cherry picking occurred (P1ES, P10GA, and P20SCM). Others were also concerned about criminal elements emerging, as landfill criminals dominate waste pickers to get e-waste at low costs and break-ins occur at municipal sites where e-waste is collected (P2ES and P18RDE).

Responses on how to deal with the informal sector were divided. Those who expressed negative attitudes believe e-waste should be taken to appropriate collection sites, and informal waste pickers should be forbidden to collect any e-waste by making it legally punishable (P1ES, P3ES, P11GA, and P18RDE). However, a few of the participants believed educating and training of waste pickers and recyclers on correct recycling methods is a better strategy (P10GA).

- ***Disposal of large domestic appliances (LDA's)***

LDA's refers to items that are bulky, such as stoves, refrigerators, freezers, washing machines and tumble driers.

Participants expressed two major opinions regarding this topic. The first sentiment highlights the problematic nature of these items due to their size. They assert that it is a nuisance to get rid of LDA's as the size of the items makes transport difficult and only a few consumers have pick-ups for transportation (P2ES, P3ES, P5GA, P6GA, P9GA,

P14RDE, and P15RDE). The size of these items also makes it difficult or sometimes impossible for retailers to store them due to space limitations (P20SCM).

The second point related to LDA's was that a different system for LDA collection is needed than for small appliances (P5GA, P14RDE, and P19SCM). It was proposed that LDA's must be collected from homes in a way similar to an UBER service, where a call is placed to collect someone. In this case an LDA pickup can be arranged where control is built into the system to monitor collections (P3ES, P4ES, P6GA, P9GA, P10GA, and P20SCM); the collection bookings must be done via internet or a toll free phone service, which is arranged through a centralised coordination agency (P1ES and P3ES). In South Korea, consumers already use a similar system where they call for a free collection of large household appliances without buying a new one (Manomaivibool & Hong, 2014:207).

- ***Conclusions regarding kerbside placement and disposal of small and large e-waste appliances***

Denmark typically schedules and announces four to eight collection dates per year to collect e-waste from kerbsides (Bigum *et al.*, 2013:2373). In the USA, the method of kerbside placement for collection is used 8% of the time (Kang & Schoenung, 2005:375). Participants across the four stakeholder groups agreed that placing e-waste on the kerbside is problematic in the South African scenario as it will lead to environmental- and health-related risks due to the cherry picking and unsafe practises that occur. Fractions will be left behind, copper wires will be burned, and backyard electrochemical processes to extract precious metals will occur. If the informal recycler could be trained and be able to deliver the e-waste to recyclers it would be ideal but policing of this sector is challenging. Kerbside (and refuse bin) placement should therefore never be allowed in South Africa. Preventing this placement would lead to a healthier and cleaner environment. Scrap dealers (the normal ferrous and non-ferrous dealers) are not equipped to handle household and ICT e-waste and should be prohibited by legislation to accept any e-waste fractions such as copper wires, burned copper wire and household metals. Exceptions can be made for electric motors and generators that contain only copper and some metals; this would discourage informal recyclers to cherry pick to sell valuable fractions to scrap dealers. Only e-waste approved recyclers should have e-waste on their premises.

South Africa has a very high crime rate, with the result that access to households and apartments in cities is limited due to security measures. Doorstep haggling to buy e-waste from South African households would be ineffective and should not be allowed.

The environmental specialists and government agency participants are more vocal about the problematic disposal of LDA's due to the size of items (Table C.1 in Annexure C). Suggestions for an UBER type system (Call-to-collect) would be ideal. The rules applicable to a call-to-collect should be:

- The call-to-collect must be a free for consumers.
- The system should be only for larger WEEE that cannot fit into a car, such as air conditioners, washing machines, tumble driers, large television sets, fridges and freezers.
- Small WEEE should also be accepted by the collector when LDA's are collected.
- As security is a problem in South Africa, the call-to-collect arrangements must be secure where the collector detail, date, and time of collection is confirmed via e-mail or Short Message Service (SMS).

6.6.2 Convenience is the key to effective e-waste collection

This category expresses the opinion of participants that convenience to consumers is the key to effective recycling in South Africa. Participants would, 1) welcome drop off points at places of work, and 2) would like to see dedicated and convenient drop off points. These views are reflected in the following quotations:

1) "That (Corporate e-waste collection points) would be fantastic. So places of work, schools, and community centres would be ideal. Again they need to be given the facility to be able to handle that, and you want to avoid storage, because storage comes with a whole bunch of issues." (P16RDE)

2) "That's a good idea. That is already happening in a lot of areas as you know, I mean we do have receptacles in shopping malls and we have a Desco is a recycler who's put a container at Makro, you can just deposit your old computer, laptop, TV, whatever, there...the third option would be of course, dropping it off at a nearest drop off centre, it

could be at a filling station, it could be at your nearest supermarket, it could be at a mall, whatever is convenient for you, that is accessible.” (P9GA)

- ***Corporate e-waste collection points as a potential convenient solution***

This code reflects on the concept of installing e-waste collection bins at the offices of companies with large numbers of employees. Overall the interviews support such collection points as part of an organised collection effort.

Providing a collection bin at the workplace for employees to properly dispose of their e-waste could contribute to collection efforts and companies’ corporate social responsibility (P9GA, P10GA, and P19SCM). Some participants explained that a few companies, such as Conlog and Makro (through Desco, 2019), are already actively involved in the collection of e-waste and even take on the additional responsibility to educate employees regarding e-waste (P1ES, P16RDE and P18RDE).

Not all of them were equally positive since there are potential barriers to corporate e-waste collection. One of the active implementers of e-waste collections at the workplace argued, from experience, that larger companies with e-waste bins at their offices could struggle to co-ordinate the collection efforts as it is not their speciality. The success in collection of e-waste at companies would therefore depend on bastions in the company who would be willing to drive and steer the collection process (P4ES).

- ***Current and potential allocated drop-off points***

It is crucial for methods of collection to be visible, nearby, accessible, safe, and convenient to consumers, as this will attract sufficient volumes. Overall the participants supported and encouraged the use of allocated drop off sites for e-waste. This included formal collection initiatives at large shopping malls, garden sites, and retailers where knowledgeable people would collect and do basic separation of e-waste streams.

Irrespective of the placement of a collection site, it must be safe and convenient for the consumer disposing of e-waste; the environment must be protected, and e-waste requires securing at all times to prevent cherry picking and theft. Tight control is thus needed at a manned site and only knowledgeable persons must collect and separate e-waste at these points (P2ES, P3ES, P12GA, P14RDE, P19SCM, and P20SCM).

A few of the participants were aware and positive towards the handful of receptacles at malls and retailers (P9GA, P18RDE, and P19SCM). However the need for multiple drop off points for e-waste was not met at this stage and requires extensive expansions in public spaces, such as shopping malls, retail outlets (P2ES, P3ES, P4ES, P9GA, P15RDE, P16RDE, and P20SCM) and even a small section of the parking area of shopping malls (P3ES and P20SCM). Some participants convincingly argued that manufacturers, suppliers, and retailers selling electronic equipment, such as globes and white goods, should invest more to collect e-waste and be made responsible for the waste they generate (P10GA and P14RDE). The role of retailers could be to act as regulated return points, collecting LDA's when delivering new equipment, and informing consumers on e-waste returns and handling (P3ES, P10GA, P14RDE, and P16RDE). However, taking back old equipment can become expensive due to additional space required to store e-waste (P20SCM).

The South African government should make it a legal requirement for retailers to take back e-waste as the limited collection infrastructure in SA is in stark contrast to the developed e-waste collection networks in other countries (P3ES and P14RDE). In China, collection centres are placed inside convenience stores as it is convenient and educates the public about e-waste generation, environmental pollution, and the nature of resources and the hope is that the public will access certified collection points spontaneously (Yu *et al.*, 2014:1712).

Participants believed that garden refuse sites could be transformed into ideal drop off facilities (P1ES, P3ES, P11GA, and P13GA). The current setup of garden refuse sites is not yet suitable for this purpose, but future sites can and must be turned into integrated waste management system to accommodate all waste types, especially e-waste (P10GA, P11GA, and P16RDE). This would be in line with EU countries who have collection points called "civic amenity facilities," with the purpose of collecting recyclable household waste such as green waste, metals, glass and WEEE. When a specified quantity of e-waste has been collected, the e-waste management system would collect at these facilities (Sander *et al.*, 2007:139).

In Germany the facilities are called public waste management authorities (PWMA), and the discarded products are distributed from these facilities to recycling companies (Walther *et al.*, 2010:467). In the USA the public collection sites are called municipal solid waste collection sites, WEEE can be taken to these facilities and this method is the most used option (47% of the time) and is described as the most cost effective option in the USA (Kang & Schoenung, 2005:375).

- ***Conclusions regarding convenience as the key to effective e-waste collection***

If consumers have knowledge of recyclable materials, live in close vicinity to a collection site, and have the desire to go to such a site, then they experience the convenience of a collection system. In addition, if the drop-off hours for materials are extended and consumers experience ease in the process, this will maximise consumer participation and be the key to increasing the total collection amount of waste (including e-waste) (Wagner, 2013:499). The importance of convenient collection found in the current study corroborates literature, which proved that the inconvenience of e-waste collection infrastructure will lower the rate of consumers participating in these activities. Even though UAE consumers are very positive towards recycling efforts, travelling long distances and a shortage of recycling bins had a negative impact on recycling habits (Bendak & Attili, 2017:7). From a Romanian point of view, the outstanding factor which prevented the country from reaching a collection target of 4kg/capita was the lack of a proper collection infrastructure (Popescu, 2015:268).

The lack of a collection infrastructure and consumer knowledge on e-waste are the biggest factors in South Africa which prevent e-waste collection. Corporate entities should be encouraged, not forced, to collect household e-waste should they have the infrastructure and capabilities to collect e-waste.

Receptacles inside and outside shopping malls are needed as this is where consumers go for leisure activities as well as for shopping. The convenience factor will also be addressed using this method. The bins currently used at the Makro centres are not acceptable as the aperture size only allows small e-waste items to be disposed. The height and setup do not allow CFL tubes/globes disposal as breakage can occur.

The bins need to be lockable to prevent break-ins and manned by trained personnel who will keep the area clean and healthy, receive and document e-waste, and store the e-waste for transport at a later stage. The safety of consumers would also be ensured as informal collectors can be a nuisance at these bins.

It is law in Japan for retailers to take back WEEE (Yoshida & Yoshida, 2010:22). A similar law should be introduced in South Africa but could be problematic for some retailers due to limited retailer storage space. Retailers with this problem should get special permission not to fall under this law, but direct the public to another collection point. The EU Directive (2012/19/EU) forced European retailers to accept WEEE devices when a customer buys a new or similar item from the 1st of May 2013. The directive also forces electronics shops larger than 200 m² and grocery shops bigger than 1000 m² to accept small WEEE, with dimensions no greater than 25 cm, without any obligation (Ylä-Mella *et al.*, 2014:42). Similar regulations could be introduced for South African retailers.

During the investigation phase, some “civic amenity facilities” sites in the Netherlands and Belgium were visited by the researcher. These large sites allow access for many large vehicles transporting different waste types. Strict control was exercised at these sites and they were designed to accommodate and separate WEEE into different streams. The existing South African garden refuse sites are unsuitable for e-waste collection due to space availability as well as the lack of proper control and security after hours. Current garden transfer stations should not be used to collect e-waste, except if dedicated provision was made at the sites for collection of e-waste. Future transfer stations should be built with recycling in mind, where knowledgeable personnel will accept and store recyclable materials.

In a Canadian e-waste feasibility study, it was taken as a norm and suggested that one collection point should be set up for every 50 000 inhabitants in a country (UNEP, 2007b:45). The WEEE report (2013:39) indicated that the collected waste in 2012 for Canada ranged from 3.34 kg/person (Ontario) to 5.61 kg/person (Saskatchewan), with an average collection of 4.53 kg/person/year. It should also be noted that the average percentage of consumer awareness in Canada recycling is a high 76.4%.

With a South African population of around 55 million people and using the Canadian model, the number of South African collection points should thus be around 1100. The biggest cities, such as Cape Town (3 433 441), Durban (3 120 282), Johannesburg (2 026 469), Soweto (1 695 047), and Pretoria and Centurion combined (1 619 438+233 386=1852824), would need 69, 62, 41, 34, and 37 (32+5) collection points respectively (World Population Review, 2019).

If Pretoria and Centurion (Urban areas of Tshwane metropolitan area) are used as an example, the current collection points available can be analysed. There are 18 landfill- and garden refuse transfer sites recorded (City of Tshwane, 2014), and some sites could be adjusted to become e-waste collection points. If retailers selling EEE become collection points, then there are 13 Pick and Pay stores (Pick n Pay, 2016), nine Builders Warehouse stores (Builders, 2016), 23 Checkers and Checkers Hyper stores (Checkers, 2016), 12 Shoprite stores (Shoprite, 2016), three Hi-Fi Corporation stores (Hi-Fi Corp, 2016), four Deon Wired stores (Deonwired, 2016), eight Game stores (Game, 2016), and 21 Super Spar stores (Spar, 2016). The minimum number of stores that could be used as collection points for the Tshwane Metropolitan area equal 111, and this is not a complete list of possible collection and drop off sites. The Pretoria/Centurion area already has three times the collection points compared to the Canadian model, which suggests 37 collection sites for a similar population size. Disposal facilities should thus be accessible and convenient for consumers in this metropolitan area. Similar scenarios are expected in other metropolitan cities.

6.6.3 Authorised mobile e-waste collection

This category reflects on the role of authorised entities and municipal trucks in e-waste collection on specific days in specific areas. Views on 1) authorised mobile e-waste collection and, 2) municipal trucks involvement in collection are depicted in the following quotes:

1) *“According to me it should be collected by authorised responsible collectors who are going to take it to centres where it will be properly dismantled and/or refurbished.” (P1ES)*

2) *“Yes, but municipalities I don’t think are motivated to do it. You’ll need to motivate them. People like, what’s it, the recycling people would be interested in doing that, and they’ve been struggling with that for a long time.” (P15RDE)*

- ***Authorised and organised e-waste collection entities***

Some participants were of the opinion that safe e-waste collection must be formally conducted using a mobile unit collecting at a specific site on a specific day of the week or month. This should be different from normal waste collections as consumers must bring their e-waste to the unit to dispose of it.

This method is proposed for city disposal and for small town collection initiatives due to the lack of economy of scale and storage facilities (P1ES, P2ES, P3ES and P5GA). E-waste must only be collected by authorised and formally contracted entities who will be accountable, while the informal sector should not be involved (P1ES).

This method of collection is frequently used in the USA and the preferred method in rural USA. The dates and the collection point/s are announced in the media and occur a few times per year (Kang & Schoenung, 2005:375). In small towns and sparsely populated municipalities in Finland, the municipalities or regional waste management companies inform local inhabitants of the practical arrangements before the collection dates, typically once or twice per year (Ylä-Mella *et al.*, 2014:42). Mobile units are already in place for the packaging industry where consumers take paper to the mobile units, it is weighed and consumers are paid using a debit card system to avoid cash. A similar system could be employed to collect e-waste as well, but to guarantee success the event must be promoted by different media sectors (P3ES).

- ***The role and limitations of municipalities in e-waste collection***

Participants suggest it would be ideal if smaller items of e-waste could be collected via municipal services along with general waste (P9GA, P10GA, and P16RDE), however some potential limitations associated with municipalities were expressed. Municipalities might lack motivation if it does not generate additional income (P15RDE), and safe disposal and recycling are not guaranteed once e-waste has been collected by municipalities (P20SCM).

The interviews revealed a strong belief that municipal trucks are incapable of currently collecting e-waste. Several reasons driving this option could be identified. Municipal policies require collection at a household once a week and it would be difficult to change the municipal policy to specifically collect e-waste (P11GA and P13GA). Municipal trucks are designed to collect normal solid waste and crush them, something which cannot be done to e-waste as that will increase exposure to the environment from items such as toners, cartridges and CFL bulbs (P4ES, P10GA, P12GA, P13GA, and P14RDE). Municipal trucks are thus not geared to collect e-waste (P4ES, P9GA, P10GA, P14RDE, and P20SCM). Not only would it be a logistical nightmare, it would be very costly to collect e-waste through the municipal system as these trucks need to be altered, or trailers would have to be attached. Ultimately a new fleet of vehicles would be needed (P2ES, P9GA, P10GA, P11GA, and P12GA). A major concern is who would pay for these changes (P9GA) as municipal trucks are normally contracted out to private companies who would not be willing to do so (P18RDE).

- ***Conclusions regarding authorised mobile e-waste collection***

The suggestion from some participants that e-waste must be collected on specific days of the month at specific places would be beneficial to the e-waste industry. The collection method would also work in rural areas as well as the countryside, as single transport trips would make it economical. A collection day similar to the proposals from the participants was initiated by the environmental section of a political party in Pretoria. The researcher attended this event, which was a huge success, where two large trucks were filled with e-waste. A major driver to the success of the event was effective advertising in local newspapers and on community radio stations. For this collection initiative to be effective, consumers must constantly be reminded in the media and collections must consistently be done, e.g. every first Saturday of a month at a specific school, this would encourage consumers to dispose e-waste. Contrary to Denmark, where small WEEE can be placed in a small plastic bag on top of the household waste bin (Bigum *et al.*, 2013:2373) the South African scenario does not allow for this due to the cherry picking problem and possible breaking of CFL bulbs and authorised mobile collection days would be an alternative disposal method.

The South African municipal involvement to collect e-waste must be limited to making space available at refuse sites as municipalities do not have the capabilities to do the collection and distribution of e-waste to the correct recycler. This suggestion is supporting the findings of an audit conducted by the civil rights group Afriforum. The report revealed that only 26% (20 out of 76) of audited municipal sites complied with minimum acceptable norms expected from landfill sites. Municipalities thus struggle to maintain and operate general refuse sites and the addition of e-waste collection would just add problems to the recycling and disposal of WEEE. It was noticeable that the government authorities were most vocal in the fact that municipal collection trucks were not equipped at this stage to collect e-waste (Table C.1 in Annexure C), a situation not likely to be changed (due to high costs) to accommodate e-waste. In some metro cities refuse removal services are contracted out to private entities who would probably not change their vehicles to accommodate e-waste. Municipalities struggle to comply with normal municipal waste collection, do not have the infrastructure or capabilities, and should thus not collect e-waste.

6.6.4 Rural area e-waste collection

Although the study focused on household collections from urban areas and the survey was only done on large cities, the comments from participants were included in this section as household e-waste collection for rural areas needs to be incorporated in a final e-waste management framework.

This category focuses on the collection of e-waste in rural areas as they, 1) need different incentives compared to urban areas, and 2) it gives ideas for collection and community empowerment. These views are depicted in the following quotes:

1) "It can work, but it depends on the area, it's not a one size fits all, some, especially in the suburb, because to them recycling is not an issue, we'll be happy to pay a recycling fee, but imagine me staying in an informal settlement, not affording to pay a bread, not affording to take my son to school, and you expect me to pay a recycling fee." (P10GA)

2) *“Luckily for us, because we offer a bit of a financial reimbursement for the electronic waste, we try to do our best to keep everything off the roads. Once again, having your OEM’s and your manufacturers participate and get more involved in community upliftment, and generate an income, and generate employment, you know...” (P14RDE)*

- ***Rural areas need different incentives***

The interviews revealed opinions that those in rural areas need more of an incentive to motivate them to recycle e-waste. There needs to be something they can gain from it, while those in more urban or upper-class areas tend to be more driven by a social consciousness and a want to do what is right.

In urban areas consumers are more susceptible to engaging in recycling, and actually want people to see them doing it (P19SCM). Rural areas, conversely, have poverty issues and consumers would rather pull equipment apart to get hold of copper and valuables than just part with it (P1ES, P10GA, and P20SCM). Participants are of the opinion that rural communities would be persuaded to participate in collection if rewards (e.g. money and food parcels) were to be received for the e-waste (P1ES, P3ES, P10GA, P18RDE, and P19SCM). Rural communities do not have the luxury of environmental consciousness if food and daily activities which need money are a struggle (P3ES, P9GA, and P18RDE), but incentives for e-waste in the beginning stages would lead to environmental consciousness in the future (P2ES). Failure to incentivise e-waste collection in rural areas will only see it end up in the environment or landfills (P10GA and P18RDE).

- ***Rural collection ideas and community empowerment***

The interviews revealed that recycling, refurbishing and collecting of e-waste was a potential opportunities for rural community empowerment and job creation in rural areas. With regards to consumer responsibility and recycling methods, such as allocated drop offs, rural areas have somewhat different needs. Drop off points should be placed where it is easily accessible to rural communities. This could include public places such as clinics, churches, schools, local markets and spaza shops. A spaza shop is small informal convenience shop in a township in South Africa, usually run from a private home (Collins Dictionary, 2019).

With involvement from producers, the community members can be uplifted by being part of collection initiatives which will generate income and employment opportunities (P1ES, P2ES, P10GA, and P14RDE). Vehicle access in rural areas is problematic and collection of e-waste is thus challenging, calling for drop off centres (P1ES, P5GA and P17RDE). A suggestion is for the placement of six or 12 metre containers in rural areas, where trained community members buy e-waste as well as other recyclable materials from collectors and consumers in the area, disassemble the e-waste, and sell fractions with a monetary value such as plastics, metals, glass and circuit boards, to e-waste recyclers (P1ES, P2ES, P10GA, and P14RDE).

- **Conclusions regarding rural area e waste collection**

In rural South Africa, security features are different from what is seen in urban areas and access to consumers are better. In China, peddlers do doorstep haggling and collection to buy e-waste, which is done on an informal basis and contributes to the recycling of e-waste (Sthiannopkao & Wong 2013:1150). This method to buy and collect e-waste could possibly work in rural South African but needs further investigation.

Incentive schemes to encourage South African rural communities to part with the e-waste should be considered. The schemes should however train rural consumers not to break up the items and they should be educated on e-waste hazards. Setting up of drop off points is needed to allow community members to bring paper, plastics, glass, metal and e-waste to the collection point. This would benefit recycling and the community as a whole, as members would get something in return and jobs would be created for the unemployed.

6.6.5 E-waste separation stages

This category sheds light on, 1) the importance of separation of e-waste from other types of waste at source and, 2) the importance of leaving e-waste intact for knowledgeable recyclers to do the separation. The following comments reflect this idea:

1) *“So separation at source, not just for e-waste, but for all waste streams, needs to start at home.” (P2ES)*

2) *“The reality is, when it comes to the public, it really can’t be up to the public, because all you need is one person to make one mistake, and it stuffs the whole system up. So realistically it cannot be the public who is in charge of separating, it has to be some other mediator, or an immediate organisation, so that would probably be your aggregators.”*
(P4ES)

- ***Importance of separating e-waste at source***

The participants were of the opinion it was the responsibility of each household to separate their own e-waste from their general waste, which is important because e-waste can contain hazardous materials which can contaminate all the waste surrounding it as well. Further separation should occur at collection points to prevent spillage and breakages.

Participants agreed that separation at home of e-waste from general waste was extremely important due to the toxic nature of the waste stream (P1ES, P2ES, P3ES, P4ES P5GA, P9GA, P14RDE, P16RDE, and P19SCM). E-waste should not be allowed in the same bag as rigid e-waste as this could damage breakable e-waste such as CFL tubes and release toxic mercury vapours. If separation does not occur at source, the logistics to extract e-waste further down the line becomes a nightmare (P1ES).

When e-waste is received at drop off points or retailers further separation should commence with skilled personnel who can handle the basic separation (P4ES, P9GA, and P19SCM). E-waste is, and should be, removed from the rest of the waste at transfer stations (P5GA). With separation at different stages value is added as different streams are formed (P4ES).

- ***Minimised e-waste streams must be separated by knowledgeable persons***

Participants believed that different streams of e-waste should be minimised and not be separated from each other as the public cannot be relied on to separate waste correctly, and one error could mess with the entire system (P4ES).

These participants preferred knowledgeable collectors and recyclers to separate e-waste into different streams at the collection points, as separation involves health and safety issues which only knowledgeable persons can comply with (P4ES and P19SCM).

Persons with knowledge about the different e-waste types are essential at these points from where the e-waste will be distributed for recycling, e.g. cooling equipment will go into a different stream from PC equipment (P3ES, P5GA, P9GA, P12GA, and P15RDE). This falls in line with the South African e-waste setup where the industry is grouped between tier-1 and tier-4, where tier-1 is the basic collectors and tier-4 will be the e-waste recyclers which specialise in different streams (P16RDE).

- ***Conclusions regarding E-waste separation stages***

Consumers are not aware that e-waste is hazardous and will keep on discarding it through the normal waste bins or bags. Legislation should prohibit the disposal of any e-waste items into the normal refuse bins or bags and should be punishable through fines. Education through the media is needed to make consumers aware of the hazardous nature of e-waste.

Knowledgeable persons should do basic separation at collection points to prevent breakages and spillage. This suggestion is supported by researchers in Spain who call for the maintaining of product quality through improved access to collection points and the improvement of separation at source, as this will increase the number of items which can be reused or recycled (Zeller *et al.*, 2018:93). At the same time, breakable items must be protected when transported from the collection point.

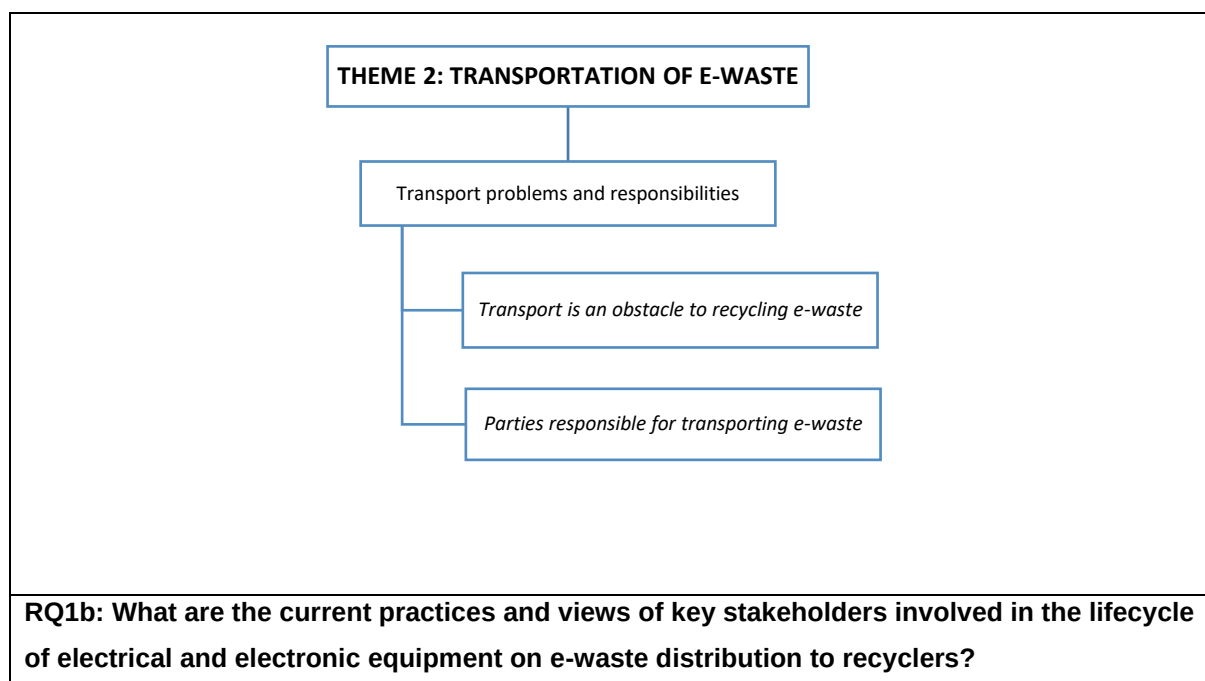
The assumption from some participants was that e-waste streams would go from collection points to the respective recyclers. Should this be the way, then separation into the different streams must occur at the collection points. The disadvantage of this approach is that different transport arrangements would have to be made from different recyclers, which could create parking and storage space problems at the collection site. It has been calculated that separate collection and transportation are generally the most expensive steps of the WEEE reverse supply chain and it is therefore crucial to set up an efficient collection system (Achillas *et al.*, 2010:2599). For this reason, another system, called an auction house system, is proposed in the last theme. Knowledgeable persons must do the basic separation of breakable items at the collection point but the final waste streams, going to approved recyclers, should occur at a different place. This could be at an auction house or a separation station.

The preceding sections addressed the “Collection” and “Pre-Processing” sections, as seen in the conceptual framework. “Pre-Processing” was highlighted as participants believed that separation must start at home.

6.7 RESEARCH QUESTION 1b AND THEME 2:

In Figure 6.4 theme 2 of the findings addresses research question 1b: ***What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste distribution to recyclers?***

Figure 6.4: Research question 1b with related theme, categories and codes



6.8 THEME 2: TRANSPORTATION OF E-WASTE

Theme 2: Transportation of e-waste relates to problems associated with transporting e-waste as well as which party should be responsible for the transporting of e-waste. The category and associated codes will be presented in the next sections.

6.8.1 Transport problems and responsibilities

The category highlights, 1) the complicated legislation regarding e-waste transportation and the obstacles that are faced if the correct vehicle is not used for transporting e-waste and, 2) who should bear the responsibility of transporting e-waste. According to participants, the responsibility should be carried by either recyclers, producers or a proposed auction house, which will be discussed in more detail as the last theme of the chapter. The following extracts exhibit some of transportation related challenges as articulated by participants:

1) *“Transport for e-waste can be very expensive, especially if there’s no, let’s say maybe a light knock down of the equipment, because it’s all about volume, and if you talk about e-waste categories, I mean, if it’s not knock down or semi dismantled, it takes quite a bit of space. So it’s quite expensive.” (P19SCM)*

2) *“...they’re not included in that same contract, and like for instance, if we have the Game and the Pick ‘n Pay, we will take it from them, so it depends on who’s got the contract. That person will transport. If it’s big enough volume that comes from that site, then we can get the actual recycler involved who will collect it from and on our behalf from that store then, but in most cases we (collecting, separating, and disposal company) take it and then take it to them.” (P18RDE)*

- **Transport is an obstacle to recycling e-waste**

Participants were of the opinion that Government overregulates the transporting of e-waste, making matters unnecessarily complicated as the majority of e-waste, if not broken, is not dangerous and could be transported by normal roadworthy vehicles. Transport is costly and economy of scale should be implemented to ensure efficiency.

When new household electronic equipment is transported, no hazardous waste licence is needed, according to South African law, but when it comes e-waste the transporters have to have a hazardous waste licence, this while the risk of contamination is minimal. Transporting e-waste is thus overregulated, as the minimum requirements should be roadworthiness and an enclosed vehicle (P3ES).

E-waste takes up a lot of space in vehicles when it has to be transported (P2ES, P9GA, P10GA, P15RDE, P19SCM, and P20SCM) while the weight is comparatively low, resulting in transport of e-waste being expensive and the biggest cost factor in the logistics recycling chain. Economy of scale for e-waste transport is needed as small volume collections are inefficient expenditures (P2ES and P10GA). Funding of e-waste transport has a huge question mark around it (P1ES) and for cost effective transport of e-waste it is imperative that coordination of the transport and collections be centralised (P16RDE). Participants furthermore expressed the view that collected e-waste from either rural or urban areas must be returned to a major collection hub to ensure grading into different e-waste streams is done (P3ES and P16RDE).

- ***Parties responsible for transporting e-waste***

Participants have three distinct views on who should be responsible for the transport of e-waste. Some participants were of the opinion that the recycler must pay for the transport of the e-waste (P9GA, P10GA, P14RDE, P15RDE, P18RDE, and P19SCM) as they already have their own vehicle fleet (P14RDE) and could benefit financially from the exercise (P4ES, P9GA, P10GA, and P18RDE).

Others have the opinion that producers of e-waste must fund and pay for all logistical operations, from collection to disposal at landfill or recycling facilities (P5GA).

A third view was also expressed where both parties pay for transport. These participants expressed the view that a central collection hub is needed where e-waste is taken after collection to be sorted into the different e-waste streams (P3ES, P9GA, P14RDE, and P16RDE). Participants were in support of producers being responsible for the transport, and funding, from collection points (drop off points) to the collection hub (P4ES, P14RDE, and P15RDE) while recyclers need to transport, and fund, the e-waste to their recycling facility (P9GA and P14RDE).

- ***Conclusions regarding transport problems and responsibilities***

Vehicles could indicate that e-waste is being transported but the strict hazardous vehicle licenses legislation should be changed for household e-waste. E-waste must be separated in the minimum streams at the collection points to prevent breakage and contamination.

The storage categories should be divided into display equipment containing CRT's, Gas discharge lamps (e.g. CFL's), and all other WEEE types (UNEP, 2007b:39-40). Transport of the items should be done in strong bins to prevent breakage and the bins should easily be lifted onto transport vehicles using a forklift. Vehicles transporting CFL lightbulbs should have proper ventilation in the event of an accident and the vehicle should have indications that mercury-containing items are being transported. Appropriate collection trucks together with a co-ordinated collection schedule will thus ensure economy of scale, as only filled bins would be collected, maximising collection efficiency.

Regarding the costs associated for the transport of e-waste to recyclers, some participants were of the opinion that the recycler must pay for the transport of the e-waste, as they will make money from the exercise. The problem with this approach is that recyclers handling negative value items (expenses higher than income) would not be able to afford these transport costs.

Others proposed that producers must pay all transport costs. A central collection hub, from where urban and rural transport co-ordination takes place, would be ideal if producers were to pay for all the transport arrangements as suggested. Received e-waste can be separated and distributed to recyclers who were approved, while producers have control of the system. It is suggested that all transport payments to the central collection hub need to be covered by producers. Recyclers dealing with negative value items need to be compensated for transport, while recyclers dealing with positive value items need to pay their own transport.

In the conceptual framework, "Transport/Distribution" was highlighted as an area of investigation. The preceding sections, theme 1 and theme 2, shed light on the best transport practices as envisaged by stakeholders.

6.9 RESEARCH QUESTION 1c AND RELATED THEMES 3 to 7

Table 6.2 presents the themes with their related categories and codes of the findings which addresses research question 1c: *What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?*

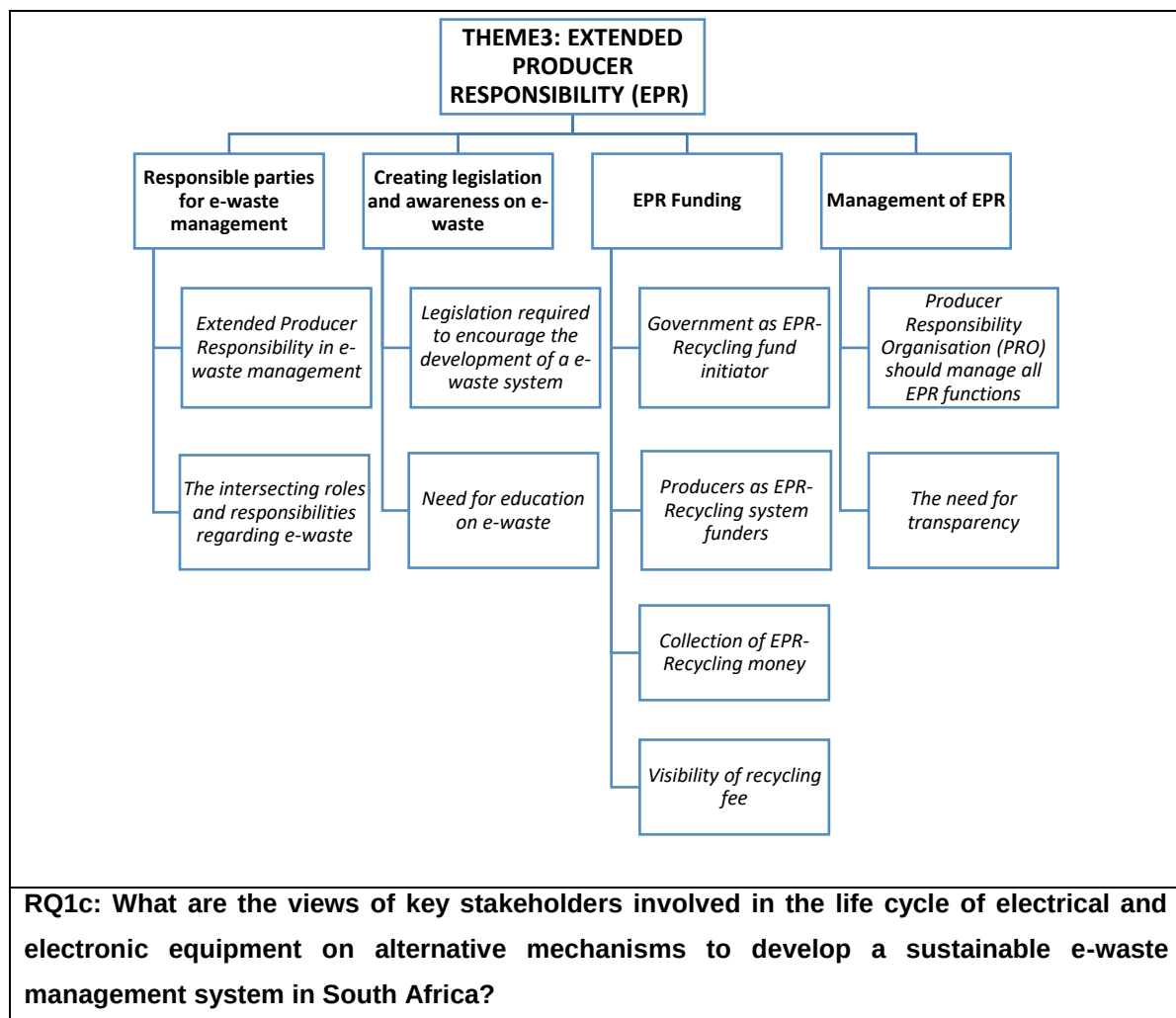
Table 6.2: Research question 1c with related themes, categories and codes

RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?		
Themes	Categories	Codes
3. Extended Producer Responsibility (EPR)	• Responsible parties for e-waste management	• Extended Producer Responsibility in e-waste management
		• The intersecting roles and responsibilities regarding e-waste
	• Creating legislation and awareness on e-waste	• Legislation required to encourage the development of an e-waste system
		• Need for education on e-waste
	• EPR Funding	• Government as EPR-Recycling fund initiator
		• Producers as EPR-Recycling system funders
		• Collection of EPR-Recycling money
	• Management of EPR	• Visibility of recycling fee
		• PRO should manage all EPR functions
4. Problem areas regarding recycling infrastructure in South Africa and the role of government to address the recycling needs	• Recycling shortcomings and needs	• The need for transparency
		Lack of recycling facilities in areas and on specific e-waste types in South Africa
	• Government's involvement in addressing e-waste recycling needs	• Lack of electrical equipment refurbishing centres
		• Government should facilitate recycling e-waste
		• Government should set up legislation
5. Producer Responsibility Organisation (PRO)	• PRO Preferences and functions	• Government corruption
		• In favour of a PRO steering the system
		• In favour of a single PRO stream
		• The PRO should involve many parties
		• The PRO should be independent
6. Take back scheme & reward system	• E-waste reward system to discourage hoarding	• The need for a Registry
		• Consumers are hoarding e-waste
	• E-waste take back system	• Implementing a reward system
		• Take back schemes
7. Proposed Auction house	• Arguments for and against auction houses	• Take back should be part of legislation
		• The existing format of auction houses
		• Auction houses would be problematic
		• In favour of auction houses for e-waste

6.10 THEME 3: EXTENDED PRODUCER RESPONSIBILITY (EPR)

In Figure 6.5, theme 3 of the findings addressed research question 1c: *What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?* The four categories and associated codes included in this theme are interpreted in the following sections.

Figure 6.5: Research question 1c with related themes, categories and codes



Theme 3: EPR relates to a strategy to protect the environment by reducing the impact on the environment from a product by holding manufacturers (producers) liable for the take-back, the recycling, and for final disposal of the products, thus for the entire life cycle. EPR is executed by means of informative, administrative and economic instruments.

The configuration of these instruments governs the precise form of the EPR (Lindhqvist, 2000:37). Concerning the concept of EPR, the participants have revealed diverging opinions on who should fund and manage the EPR funds. Many participants believe that the South African government should not be in charge of the EPR funds because they mistrust them. In response to the question of whether consumers should be aware of recycling fees, participants opted for either a built-in or a visible recycling fee, as some argued that a visible recycling fee would increase consumer responsibility by making consumers think twice about their purchases.

6.10.1 Responsible parties for e-waste management

This category reflects on 1) the views regarding EPR and, 2) potential parties who should take responsibility for e-waste, as well as the government's role in the e-waste system. The following extracts exhibit some of EPR related challenges as identified by participants:

1) *"....I think the thing they should have here is the extended producer responsibility that should be implemented with the industry waste management plan, it means when you purchase it, you already paid for the responsibility [Of recycling] of it." (P5GA)*

2) *"In other cases, I think additional responsibility by the product manufacturers is needed, because that kind of recycling technologies should start being invested in in this country, we shouldn't be selling our circuit boards to China for recycling. I believe that is the responsibility of the manufacturers and the producers to be investing in that" (P12GA)*

- **Extended Producer Responsibility in e-waste management**

Participants agreed on the urgency for an EPR programme to be initiated in South Africa (P1ES, P4ES, P5GA, P9GA, and P15RDE). EPR starts with the introducing of an environmental-friendly product to the market, which should be a dynamic and South African specific mechanism that addresses current shortfalls of what is currently being done (P19SCM). The opinion is held that producers should be held accountable for setting up and running an EPR mechanism and infrastructure, fund it, and ensure consumers do not pay when they want to dispose of e-waste items (P2ES, P4ES, P9GA, P10GA, P11GA, P12GA, P16RDE, and P19SCM).

Some argued that the government is in favour of EPR because it allows them the shift responsibility to producers. A challenge with an EPR system is that government is often very short-sighted on the EPR methodologies and sees it as creating an additional tax which could assist government in terms of doing many other functions (P19SCM).

- ***The intersecting roles and responsibilities regarding e-waste***

Participants are of the opinion that everyone in the value chain should be responsible for e-waste recycling. This would include all role-players such as the government, producers (manufacturers, importers and distributors) retailers, consumers, municipalities, e-waste associations and recyclers. (P1ES, P10GA, and P14RDE).

Producers, as the manufacturers or importers of EEE, should be responsible to inform consumers of the hazardous nature of e-waste, how to handle it, and what to do with it at disposal (P1ES, P2ES, P4ES, P10GA, and P14RDE). This can be linked to the polluter pays principle, in which those who produce the pollution are responsible for it (EU Directive, 2012/19/EU).

Retailers must have a legal obligation to take back e-waste from consumers (P3ES, P10GA, and P16RDE) and must give assistance to consumers and educate them on how to dispose of e-waste correctly (P2ES, P14RDE, P19SCM, and P20SCM).

Consumers are also a critical component in the e-waste disposal chain. As the legal owner of the e-waste, the consumer must manage the waste in a responsible manner and ensure effective disposal (P2ES, P4ES, P9GA, P11GA, P12GA, and P19SCM).

The Government is an important partner in the effective setup of an EPR system and trust between government, producers and the consumers is the basis of a working partnership. The failure of the plastic bag and tyre levies of the past has diluted trust between the parties and a governing body is needed to bring all the role players together to solve the e-waste problem (P7GA and P14RDE).

- ***Conclusions regarding responsible parties for e-waste***

EPR is defined as an environmental strategy to decrease the total environmental impact from a product (Lindhqvist, 2000:37). E-waste was specifically mentioned in the Draft framework for the National Waste Management Strategy (Waste Policy, 2008:10) for further investigation and implementation for EPR. The participants agreed that EPR was the way forward to solve the e-waste problem, as it is an international management tool to solve the growing e-waste problems of the world (Kiddee, Naidu & Wong, 2013:1237). The South African government must implement legislation, which will mandate proper care of products from producers through an EPR management process. Producers should ultimately be the responsible party to ensure that an EPR system is set up and maintained as the South African government does not have the capabilities or know how to implement or run such a system. Poor quality products should be penalised with higher recycling fees. A governing body is needed to bring all the different parties together to solve the e-waste problem. Trust, co-ordination, control, planning, organising, leadership and guidance is needed to get producers, retailers, recyclers, refurbishers, and consumers involved in the process. The researcher is adamant that the South African Government is not that body, and should they take control of this, it will turn out to be a failure as was the case with the plastic bags and the tyre initiative.

In Chapter 3 a conceptual framework for the present study was developed by the researcher (Figure 3.4). One of the headings was “End of life (EoL) Management”, which needed to be investigated. EPR and Product Stewardship as a possible management tools were highlighted in the framework. Participants clearly indicated that EPR would be the best way forward while Product Stewardship was not mentioned at all.

6.10.2 Creating legislation and awareness on e-waste

In this category the need for 1) legislation changes are presented as well as, 2) the need to educate and raise the awareness levels of the consumer regarding the dangers and advantages of dealing with e-waste forms part of this debate. This is highlighted in the following quotes:

1) *“Exactly, we can’t do anything that doesn’t come from a higher up legislation. We can’t even enforce household recycling of plastic material, it must be...legislated.” (P11GA)*

2) *“Well, the consumer itself should basically see the importance of the items being either recycled or discarded. If they don’t see the interest in thinking green, then they don’t care, and then they’re not going to contribute at all.” (P20SCM)*

- ***Legislation required to encourage the development of a e-waste system***

There is a need in South Africa for some legislation to be promulgated by Government to get producers involved and define the role of municipalities in order to run a fully functioning e-waste recycling system.

Producers are proactively participating in e-waste recycling in several other countries but in South Africa, there is a lack of involvement because legislation, or the lack of it, allows them to get away with it (P9GA). Dedicated e-waste legislation is needed from Government, as this is the only way to get all stakeholders to participate actively in a controlled manner (P1ES, P5GA, P11GA, P15RDE, and P16RDE).

Municipalities are not equipped to collect household e-waste and do not know how to handle it (P2ES), thus e-waste legislation for household equipment must be done by taking in consideration the Consumer Protection Act, the POPI Act, and the Second Hands Good Act, with legal consequences, e.g. fines to parties who deviate from the specified norms (P3ES, P14RDE, and P19SCM).

Participants are adamant that Government should initiate legislation, but definitely not manage the e-waste recycling system (P16RDE). A PRO is proposed, who must be initiated through legislation, which defines the roles and responsibilities of the PRO in order to control and manage e-waste recycling (P14RDE).

- ***Need for education on e-waste***

This code refers to the opinion that consumers need to be educated on the dangers of dismantling e-waste and possible harm to the environment and themselves, the advantages of recycling, and the importance of being actively involved to make the system sustainable.

Several participants were concerned that South African households have no e-waste system in place and do not know where to take their e-waste. This often leads to ill-informed decisions when disposing of e-waste (P4ES, P10GA, and P19SCM). Consumers must therefore be educated about the potential hazards of some equipment such as cooling equipment gasses, CRT's, and CFL's, which will create a will to responsibly dispose e-waste (P1ES, P2ES, P4ES, P10GA, P14RDE, P18RDE, and P19SCM). This can perhaps be attributed to the fact that in one survey, not a single senior municipality manager in charge of waste had a waste specific qualification (P2ES).

E-waste education for consumers should start at the selling point, where they should be informed on where to take e-waste for disposal and education and awareness should continue at these disposal facilities. Education should change the mind-set of consumers towards recycling (P9GA, P14RDE, P19SCM, and P20SCM).

Consumers must further be educated to understand that although there is money to be made from some e-waste fractions, the amounts are small and the environment and economy can only benefit from co-ordinated collection efforts which contribute to economy of scale (P1ES).

- ***Conclusion regarding legislation and awareness on e-waste***

The importance of dedicated e-waste legislation is highlighted in this section. The lack of participation by producers and other role-players can be directly attributed to the lack of legislation in South Africa and this situation makes it difficult to clarify matters (Dittke, 2009:6). Although the source being quoted is from a 2009 report, the situation has not changed since then. A 2013 report requested new ways of enforcing existing legislation which bans e-waste dumping (Lawhon, 2013:712). In Indonesia, retailers are not forced to inform consumers about proper recycling techniques with the result that the awareness regarding treatment of e-waste is low in the absence of regulation (Panambunan-Ferse & Breiter, 2013:229). A study in China suggested that education on the potential hazards of spent Lithium-ion batteries should be mandatory and legally enforced to inform the general public and the recycling stakeholders (Gu *et al.*, 2017:776). The strongest “green driver,” which refers to the benefits and initiatives associated with the incentives for ecological responsiveness, has been identified as legal and economic drivers (Andiç, Yurt & Baltacioğlu, 2012:50).

Similar complications are experienced in South Africa. A dedicated e-waste legislation should therefore be drafted for stakeholder comment and final implementation. The legislation should provide clarity on national, provincial and local levels and give direction for all parties involved. Legislation, together with dedicated educational and awareness drives, is urgently needed to address the issue at hand. The value of past recycling experience is confirmed in a Canadian study, which found that consumers who have experience with normal household recycling are willing to go the extra mile to deliver e-waste to collection points (Saphores *et al.*, 2006:199). An independent governing body should introduce and manage an initiative to ensure success, drive the process through retailer involvement and the use of the media and awareness programmes from an early stage.

In the conceptual framework, “Legislation and Regulations” was highlighted as an important aspect to be addressed. The roles of government structures to implement legislation and the role of an independent governing body to oversee regulations were highlighted.

6.10.3 EPR Funding

In this category participants discussed the following EPR Funding aspects 1) the government as initiator of a recycling fund, 2) recycling fund to be subsidised by the producer/manufacturer, and 3) effectively collection of money and consumer involvement. The following comments reflect these ideas:

1) “SARS should not be solely responsible for the handling of the recycling tax, but Treasury, DTI, and the DEA should be the combined group to ensure that the recycling tax gets ring-fenced and then distributed to the body that will ultimately steer the e-waste process.” (P17RDE)

2) “Just in terms of that. Just right at the beginning most of our electronic stuff is actually imported. So, I think in terms of importation, the company is responsible for the development or the manufacturing of those things, I think they need to contribute towards a fund, and that fund can also be utilised, you know, the money comes in, it goes into a fund, that fund can be used in terms of setting up dismantling facilities,

assist with the transportation as “P5GA“ indicated, you know, with the cost, especially in the rural areas or your outline areas, but then it can be done through governance, a mechanism that will distribute that funds.” (P8GA)

3) “[But SARS would not physically collect the money then, or would they?] “No, you see that is obviously not what we want. We don’t want SARS, because anything that is collected by SARS never seems to see the light again, but the numbers, we need the numbers, we need to know the numbers of the customer codes, we need the import volumes [Researcher-...so if Samsung imports a hundred TV’s, SARS can tell me they’ve imported a hundred, so we know Samsung must pay a hundred whatever?] “Yes, exactly.” (P3ES)

4) [On the researcher Question: “Do you think the consumer should see a recycling fee?”] “I definitely think we should. I think it’s because people can understand that they’re part of a system and that things are actually happening and that there’s actually like a sort of qualitative, quantitative numbers that are going towards something. If you’re just giving someone a product and they don’t know ... well, all the costs associated with it, they don’t really know why they’re paying so much for it.” (P4ES)

- **Government as EPR-Recycling fund initiator**

Participants voiced opinions that the South African government should initiate an EPR recycling fund, but they should not be responsible for managing the fund. A separate financial institution should collect the recycling money, then the money be allocated to and spent by an industry-led body.

Without exception, the participants are extremely adamant that government should not be responsible for the recycling fund at all. The problem being foreseen is that a tax would be imposed on different waste streams and thus be collected by the South African Revenue Services (SARS), which cannot ring-fence the e-waste recycling money. The recycling fee would be allocated to the waste bureau for further distribution to the respective waste industries, but would ultimately end up paying for housing or social grants, which is not related to environmental issues or recycling of e-waste (P1ES, P3ES, P4ES, P5GA, P10GA, P12GA, P14RDE, and P19SCM).

The focus of the South African government should thus be to initiate and facilitate the process to collect recycling money, but not to receive or be responsible for it (P4ES and P14RDE).

Participants believed that a reputable financial institution, such as Deloitte and Touche, should be involved with the collection of the recycling fund which should then be controlled and distributed by a PRO. In this way the funds would be correctly audited and accounted for (P3ES, P4ES, P9GA, P12GA, P14RDE, and P17RDE).

- ***Producers as EPR-Recycling system funders***

Some participants believed it should not be the consumer who should have to pay the recycling fee, but the producers who include the manufacturers, importers, original equipment manufacturer distributors and internet distributors. They are seen to be polluting the environment with products containing hazardous components.

In Japan, a recycling fee must be paid by consumers when they return old equipment (Yoshida & Yoshida, 2010:22). In Europe recycling funding is done through the distributor of EEE (retailers), the producers, or municipal financing models, which shows different interpretations and promulgated legislation on the financing of e-waste (Sander *et al.*, 2007:III-V). No funding models exist or are applied by the polluter (Producers) in South Africa and they should take responsibility for the waste they generate by paying a recycling fee (P5GA). This fee should not be paid by the consumer when purchasing the item, as the payment by the producer would create a closer control loop (P2ES, P4ES, P8GA, P9GA, and P10GA). The recycling fund should then be used to assist and set up recycling facilities and for transport, etc. (P8GA).

- ***Collection of EPR-Recycling money***

The code relates to potential options for the collection of a recycling fee. The resistance of participants against government being responsible for the recycling fees was expressed, but suggestions from participants propose a system where government is involved but they do not actively get control over the recycling fees.

The suggestion from participants is that as soon as EEE items enter South Africa over a border (ship, freight, or land) then SARS, in corroboration with the International Trader Advisory Commission (ITAC), captures the customer codes as well as import numbers. The respective producers would then have to pay to the PRO the recycling fees according to volumes on the market. A financial institution such as PricewaterhouseCoopers or Deloitte and Touche should then audit the numbers to ensure the correct funds are transferred to the PRO, which will be the responsible producer group controlling the recycling funds (P1ES and P3ES). In the same way, the local manufacturers could declare their respective manufactured numbers on which the recycling fee must be paid. Using this method of collection and verification the burden of collecting recycling fees will be moved away from retailers who are already overloaded with statutory requirements (P20SCM).

- ***Visibility of recycling fee***

This code refers to different opinions regarding the visibility of a recycling fee attached to a product when purchasing it. Some are of the opinion the fee should be indicated as a visible separate cost, while others feel it should be a built in cost.

Two opposite views are expressed regarding the visibility of a recycling fee printed on the purchase slip. One group supports the clear indication of the recycling fee on the receipt. They believe this will increase consumer awareness when they are confronted with the cost of recycling a product. Consumers would then also become more aware of e-waste recycling initiatives and demand effective recycling infrastructures and measures (P1ES, P4ES, and P16RDE). The second group believe that consumers should not see the recycling cost on the receipt as it should be built into the price. In line with this view, some participants believed that the consumer should be made aware of the recyclability and/or power consumption of the items. This would help consumers make informed decisions, especially if poorer quality items require a higher levy (P19SCM and P20SCM).

- ***Conclusion regarding EPR Funding***

The recycling fee levied by the South African Government for the recycling of plastic bags resulted in millions of Rand being paid to Buyisa-e-Bag, a government registered section 21 company. However little can be shown for it (Fish, 2011).

More than R1.2 billion has been collected in 13 years from plastic bag taxes but no jobs were created for the youth in the green economy industry (Chothia, 2016). The 2014/2015 report from the South African Auditor General indicated that 72% of Government Departments did not get a clean audit (South African Auditor General Report 2014-15, Media release: 2015:2). The involvement of the South African Government in receiving and administering a recycling fee should thus be limited, judged by the history of the plastic bag recycling fee.

WEEE recycling is much more complex and should be managed by producers who have the financial and administrative capability, as well as access to technical recycling processes to ensure success. Government should still have the role as overseer and ultimate enforcer of legal action if non-compliance occurs, but it must stay away from the control and management of the fund.

As the ultimate e-waste polluter of the country, the funding of the e-waste system should be done by producers, but care must be taken that the funding is collected effectively and correctly applied. The suggestions from participants involve government in a way that would ensure they have numbers to work on for future reference, but also that they do not get access or control over the e-waste recycling fund. In South Africa's public services sector the significant risks being highlighted are corruption, inefficient government bureaucracy, nepotism and cronyism, and where irregular payments and bribes are perceived to be very common (Gan-Business and corruption portal, 2020). Inappropriate and ineffective spending of e-waste recycling fees would therefore not be possible or allowed. The suggestion was supported that SARS and ITAC capture import numbers, then audited by a financial institution, the recycling fee paid by producers, and finally the fees received by the PRO for control and distribution. In a Hong Kong study, a similar recycling fund collection strategy was pointed out as a PRO control, which can win most of the support of the public (Chung, Lau & Zhang, 2011:544).

Locally manufactured product numbers should be declared and audited similar to imported numbers. Local retailers should not be burdened with the collection of recycling fees as it can be done more effectively in this way. The distrust of Government will be addressed if this recycling fund collection method is used and with proper checks and balances in place the fees would be allocated and applied correctly.

By indicating the recycling amount or the recycling efficiency on the purchase slip, the consumer would get a sense of recycling awareness which could increase recycling consciousness. Low grade products with high recycling cost would discourage consumers from buying the same product in the future. It is suggested that in the start-up phase, the recycling fee should be indicated on the receipt but as soon as awareness levels are high enough, then the Rand value should be replaced with a rating value, which should indicate the recycling effectiveness of a product; e.g. R, R+, R++, or R+++ where R+++ indicates the highest recycling effectiveness rate.

The conceptual framework highlighted “Funding” as an important issue in need of investigation. Participants clearly indicated how EPR fees must be funded and collected.

6.10.4 Management of EPR

The category highlights the facts that 1) EPR functions and EPR recycling funds must be managed by a PRO and, 2) the need for transparency, which is essential for the success of the management of e-waste. This is depicted in the following quotes:

1) “It has to be the PRO. The PRO has to be the visible component of the system. The PRO needs to take the ultimate responsibility for it, but the PRO also needs to be able to have a handle on accountability and responsibility back to the waste bureau... So that level of accountability has got to come back, but the public face of it has got to be the PRO.” (P1ES)

2) “But ja, they would have to control the funds, but at the same time it should be completely transparent...So if the public were able to see what was going on, or at least industry are able to see what’s going on and to monitor, then it will a) reduce the amount of corruption, and b) everyone will actually understand how everything’s working, and as soon as people understand how things work, they won’t second guess it.” (P4ES)

- **Producer Responsibility Organisation (PRO) should manage all EPR functions**

This code refers to the opinion that producers should collectively manage all EPR funds as well as all EPR functions, and only report to Government on targets and recycling rates.

Producers are the most knowledgeable where e-waste is concerned and from previous discussions, participants are clearly of the opinion that a PRO is needed to run the various components of an EPR programme. The PRO must be driven by the producer industry and be a visible entity looking after the needs of industry (P1ES, P3ES, P5GA, P9GA, P12GA, P18RDE, and P19SCM).

The PRO should be run without government involvement as a non-profit body, functioning autonomously, have checks and balances, enforce legislation, and manage all income and expenses of the recycling funds (P1ES, P4ES, P5GA, P9GA, P12GA, P18RDE, and P19SCM). Reporting to the waste bureau (Government) should only be on recycling rates and targets (P1ES, P9GA, and P12GA).

- ***The need for transparency***

There is a need for transparency in terms of how funds and systems are managed to increase consumer trust.

For an e-waste management system, run by a PRO, full transparency is needed where there is accountability and responsibility for all the e-waste funding received and spent. It should also be without fraud and administrative hassles (P1ES, P2ES, P3ES, P4ES, P12GA, P19SCM, and P20SCM). The REDISA waste tyre industry plan, a South African tyre recycling initiative, failed because the public and industry were not able to see what was going on (P4ES). To overcome resistance, consumers should see the different waste recycling facilities being set up and experience the results and benefits of the recycling. The PRO should thus convince consumers of recycling success. This can be done by quantifying the waste streams, benchmarking that on a yearly basis, reporting on progress, job creation and value being added to the country (P1ES and P5GA). It is thus important that civil rights groups oversee the system and take care of the best interests of the community, as they have no vested interest in recycling (P1ES and P3ES).

- ***Conclusions regarding the management of EPR***

Shifting of responsibility (partially or fully, economically and/or physically) away from the municipalities and rather towards the producer is one of the most important features of an EPR policy (OECD, 2001:9).

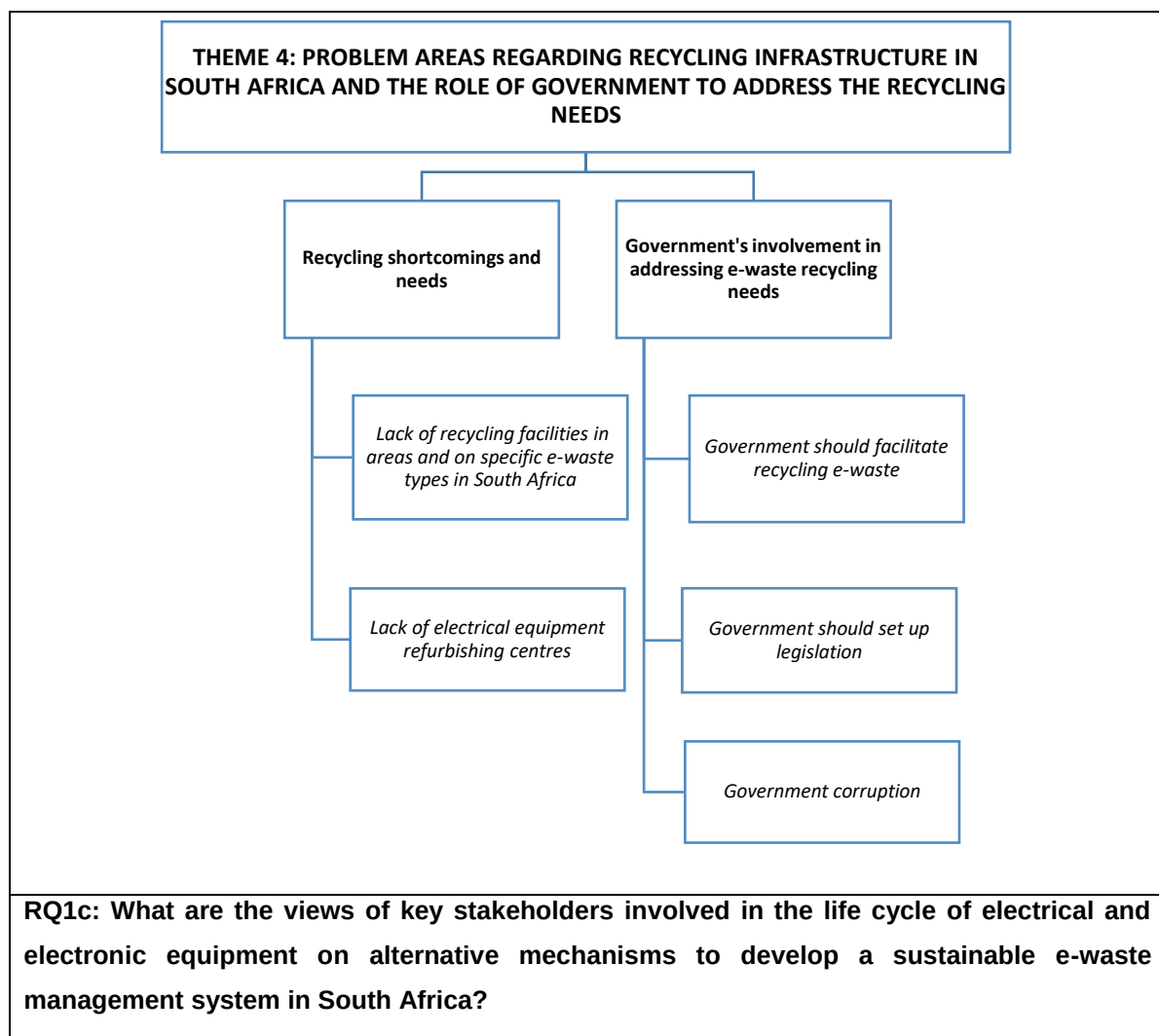
The inability of local government structures to collect e-waste and provincial/national government to run similar recycling initiatives begs for the involvement of a PRO to run almost all aspects of an EPR system and to manage e-waste recycling in South Africa. EPR is an approach that should assist government towards effective environmental control. Government legislation should ensure that EPR is managed through a PRO, which drives and steers the system to reach standards and targets which will be reported to the Government-run Waste Bureau. The PRO should therefore also be in charge of the management of the recycling funds, which would need to involve the whole e-waste structure. Punitive measures should be imposed by the PRO to all sectors and stakeholders in the e-waste industry should they not comply with the law or codes of good practice.

Transparency in the whole structure is the key to success as consumers would get increasingly involved if they saw waste facilities being erected, jobs being created, recycling numbers which increase, and a system which is governed and where fraud is not part of the system. This could be achieved if different stakeholders were involved in the PRO.

6.11 THEME 4: PROBLEM AREAS REGARDING RECYCLING INFRASTRUCTURE IN SOUTH AFRICA AND THE ROLE OF GOVERNMENT TO ADDRESS THE RECYCLING NEEDS

In Figure 6.6 theme 4, the findings also addressed research question 1c: ***What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?*** The two categories and associated codes included in this theme were interpreted in the following sections.

Figure 6.6: Research question 1c with related themes, categories and codes



In Chapter 3 a conceptual framework for the present study was developed by the researcher (Figure 3.4). One of the headings was “Ensuring compliance”, which needed to be investigated. The South African Government were highlighted under this heading in the framework as clarity is needed on role and function of Government to address the e-waste problem. Participants addressed this heading under theme 4 as the role of Government and Government corruption is highlighted.

Concerning areas that can be improved upon in South Africa, the participants have indicated several issues the e-waste recycling sector is currently facing. This theme also related to the role of the Government and how they should assist in developing an e-waste recycling system.

6.11.1 Recycling shortcomings and needs

In this category participants indicated that, 1) there are problematic e-waste categories which need recycling facilities as well as a lack in recycling facilities in some areas and, 2) there is a lack of refurbishing facilities in the local market where electrical and electronic equipment can be given a second life. The following comments reflect the ideas:

1) *"CRT monitors cap, your fluorescent tubes, toners, your laser drum toners, lithium-ion batteries, a very, very big problem for us, it's such a big problem for us...because there is no safe recycling solution in South Africa at the moment for them. So lithium, ion, nickel hydrate, CRT monitors as well as your toners, like for your HP printers and things like that, your toners is made from a very, very hard plastic, that is not easily malleable or easily re-melted and reused again, so that is a big problem for us as well." (P14RDE)*
- "...and I think all of your lower income areas are lacking that infrastructure, and obviously your rural areas, they've got nothing." (P19SCM)

2) *"So to separate them into categories, and I think definitely in terms of refurbishment, refurbishment, if you speak to a lot of the small guys, they say that refurbishment is their number one income generator, recycling as a secondary income. So refurbishment must always be on ... as a primary focus." (P4ES)*

- **Lack of recycling facilities in areas and on specific e-waste types in South Africa**

This code refers to identification of problematic recycling facilities for some e-waste categories, as well as areas in South Africa which do not have such infrastructure.

For many e-waste categories there are no recycling facilities in South Africa (P1ES, P2ES, and P12GA). White goods (also referred to as LDA's such as Fridges, freezers, and stoves) are manufactured from low grade steel, making chlorofluorocarbon, oil, and foam extraction uneconomical (P3ES, P9GA, P14RDE, P19SCM, and P20SCM). CRT's, fluorescent tubes, and toners are costly to recycle due to the facilities that are needed or disposal costs at hazardous sites (P1ES, P9GA, and P14RDE). Lithium-ion batteries and Nickel Hydride batteries were also highlighted as current problematic e-waste, which will escalate when electric cars are introduced (P4ES, P14RDE, and P19SCM).

The majority of e-waste recycling facilities are in Gauteng Province, with almost no recycling facilities in North West, Northern Cape, Free State or Western Cape (P4ES and P9GA). Very few municipalities are equipped to receive e-waste and this, together with the lack of facilities, is contributing to e-waste being dumped at landfills (P4ES and P16RDE). Rural areas and informal settlements were highlighted as areas most open to contamination or neglect due to this situation (P4ES, P12GA, P14RDE, and P19SCM).

By setting up an effective collection infrastructure all over the country, as well as recycling facilities (for problematic e-waste categories), recycled e-waste materials would be kept in South Africa and not end up in countries where environmental unfriendly practises occur (P1ES, P4ES, and P14RDE).

- ***Lack of electrical equipment refurbishing centres***

This code refers to the opinion that South Africa should focus on refurbish points as they are a great income and job generator.

Participants agreed that re-use of electrical equipment must be encouraged as much as possible and recycling should be a last resort (P4ES, P5GA, P7GA, and P20SCM). This could be achieved if the focus was on refurbishing, as jobs would be created and the life of equipment extended (P1ES, P15RDE, and P19SCM). A need therefore exists to develop certified refurbishing centres where trained personnel are employed (P1ES and P4ES).

- ***Conclusions regarding recycling shortcomings and needs***

Environmentalists highlighted the fact that the recycling facilities for some categories were non-existent for e-waste. Not a single e-waste plastics recycling facility exists in South Africa. This could be attributed to the fact that old processes only recover a very limited number of metals; new processes have however been developed to recover metals and energy (Hense *et al.*, 2015:1637). Similarly, no facilities exist for small battery, CRT screens, or cooling equipment recycling. Only one small non-operational CRT recycling facility was found during the initial investigation. It can be safely assumed that these items have a negative value (recycling will cost more than what can be recovered) with the result that the recycling fee will have to be used to construct new recycling facilities or to upgrade existing facilities.

Facilities thus need to be erected to accommodate problematic recycling facilities and the recycling fee should be used for the setting up of new facilities; operational costs would also have to be funded from the recycling fee. The establishing of new or upgrading of recycling facilities would assist in e-waste not being dumped in landfills or being transported to other countries. Following this approach, industrial symbioses would be the result, where EoL equipment, materials, and components could be re-used, which is a win-win situation (Marconi *et al.*, 2018:502).

Recycling facilities should not be set up in rural areas or in the countryside as the e-waste volumes would be too low compared to urban areas.

The results from a study in Spain indicated that from 96 units, 30.2% had to be taken for recycling directly while the rest could be either re-used or needed further evaluation for possible refurbishing (Bovea *et al.*, 2016:204). The main reason for discarding PC's were given as "lack of advanced features" as consumers expected more from this type of IT equipment (Song, Wang & Li, 2012:12). Participants in the study are in favour of refurbishing facilities as it would prolong the use of items and create jobs in South Africa. Government could play an essential role in this regard by making available training and refurbishing facilities. The PRO could ensure that training was done and a new stream of refurbished goods would be placed on the market with the added benefit of jobs being created in the process.

In the conceptual framework, a topic "Recycling facilities - Shortcomings" was indicated. Participants highlighted areas where there were recycling needs. Addressing these needs could contribute to job creation as refurbishing of equipment seems to be a sustainable source of income generation. The "Treatment/Recycling" block in the conceptual framework formed part of this feedback.

6.11.2 Government's involvement in addressing e-waste recycling needs

In this category, the role and negative attitude towards government is presented. Government must, 1) facilitate the process to set up a system to recycle e-waste, and 2) institute legislation regarding e-waste. Participants however expressed concerns about 3) corruption in government structures and stated this as the main reason for the

Government's involvement to be limited to the above two interactions. The views on this matter are highlighted in the following quotes:

1) *"Well, I think Government is the enabler, you know, so we think we've got a plan as other sectors will submit industry waste management plans, but if Government doesn't enable it by a section 28 notice, or section 18 notice, it's never going to happen. So that's Government's role..."* (P2ES)

2) *"I think they should put the legislation in place that will turn the checks and balances that has to be done, what's the internal and the external controls that should be done."* (P5GA)

3) *"The environmental impact, the hazardous impact on ... So they don't see it at all. I think the only time the Government will actually do anything about it, is if they see there's a financial gain for them, which shouldn't be the thing."* (P14RDE)

- **Government should facilitate recycling e-waste**

These comments refer to the opinion that in terms of the Government's role in the e-waste system, their main aim should be to facilitate and promote the recycling of e-waste and to spread awareness.

Participants indicated that the e-waste industry should give assistance to Government by writing the norms and standards (P1ES, P5GA, P12GA, and P19SCM) as they are the experts in the field. Hereafter Government should take on the role as implementer, overseer and regulator (P1ES, P2ES, P3ES, P4ES, P5GA, P10GA, P12GA, and P19SCM). Contrary to the past, Government should be hands-on (P10GA) and create an enabling environment by providing space for recycling facilities as well as a non-restrictive legislative environment (P1ES, P2ES, P3ES, P4ES, and P12GA). Some form of public education should also be part of the Government's involvement (P3ES).

- **Government should set up legislation**

In terms of the Government's role in the e-waste system, they should be responsible for setting up legislation. Government should set up legislation using the norms and standards received from the expert stakeholders in the e-waste industry to ensure a fair, level playing

field which has auditable checks and balances (P3ES, P4ES, P5GA, P15RDE, P18RDE, P19SCM, and P20SCM). As a first step, the dumping of e-waste in landfills should be banned (P1ES and P16RDE), but at the same time legislation must also be achievable (P3ES and P20SCM) and specific at all levels of government, namely national, provincial, and local (P1ES).

- ***Government corruption***

This code refers to a mistrust in the South African government and a belief that the Government is corrupt. Participants want the Government not to interfere with current efficient recycling facilities and to allow PROs to manage the e-waste recycling system.

All participants were of the opinion that the South African Government should not take charge of the management of the e-waste scenario as they have political priorities, do not see the environmental impact, and cut corners in terms of health and safety regulations. Due to the plastic bag and REDISA problems, participants see the South African Government as a corrupt institution who wants to fill their coffers for personal and political use.

There is a concern that if SARS collects any recycling fees, it might disappear and the Waste Bureau would dilute income with no transparent feedback (P1ES, P3ES, P4ES, P5GA, and P14RDE). The examples of the plastic bag and REDISA mismanagement were cited as reasons for the distrust in the Waste Bureau to run the waste sector (P5GA and P7GA). The view is that any recycling fees needs to be spent on the intended purpose and not for Government to make money from it (P3ES and P4ES).

Some participants acknowledged that there are some recycling systems in place. They believe that the Government should not shut down or interfere with these, as it will result in producers leaving these systems, which would be detrimental to e-waste recycling (P3ES). The industry therefore need commitment from Government, but a PRO should handle e-waste management, as this is the only way consumers would get any benefits (P3ES and P5GA).

- ***Conclusions regarding government's involvement in addressing e-waste recycling***

Government has a role to play in creating an enabling environment by providing facilities such as municipal facilities where e-waste can be collected. Government should start the process by inviting industry role-players and request a set of norms and standards from which legislation can be promulgated. Once the legislation is in place it should be steered by the PRO without any government involvement. Should problems occur, then Government should step in and have only a refereeing function. Legislation should be non-restrictive, implementable, achievable, and have auditable checks and balances.

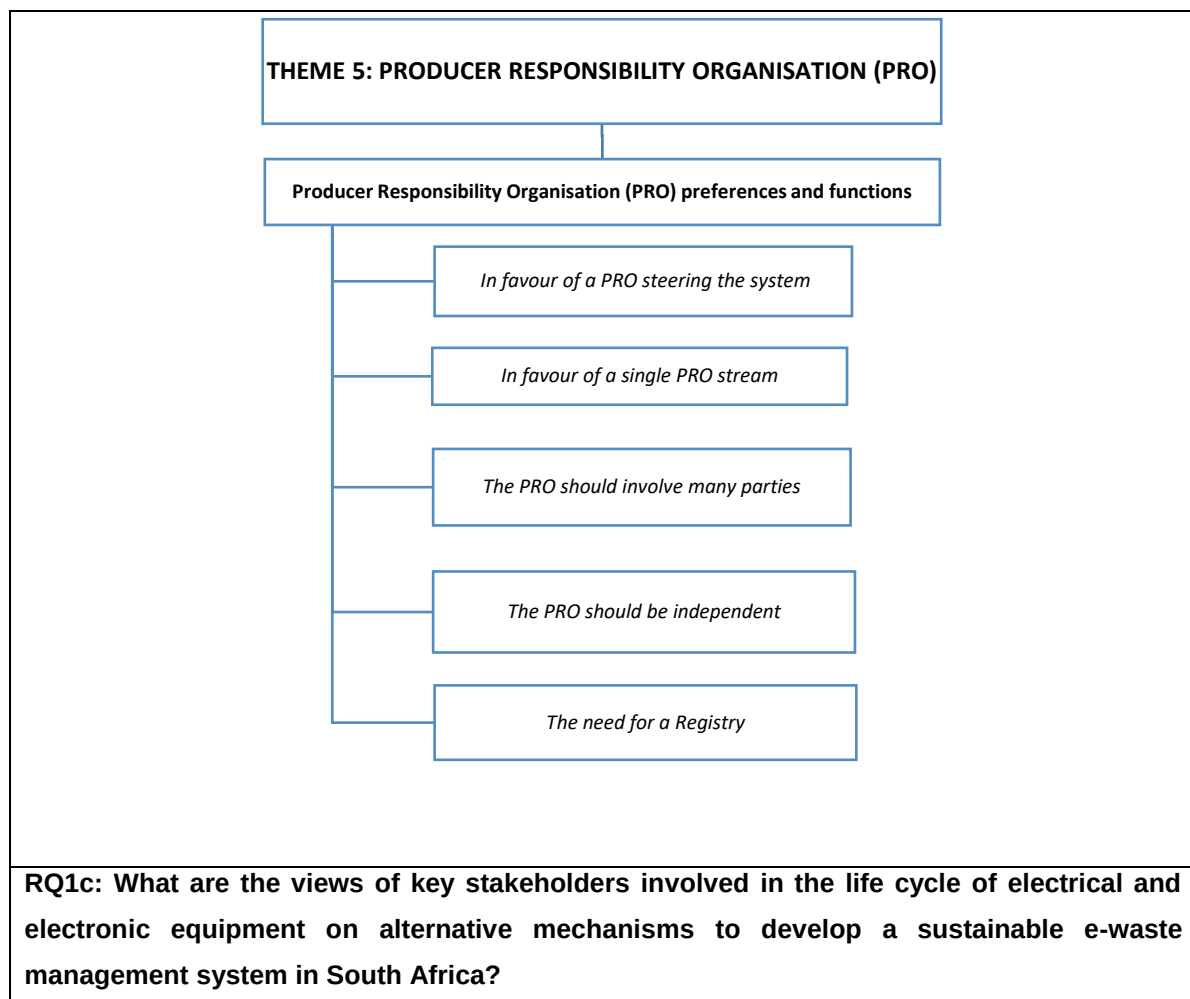
A lesson can be learnt from Australia, who promulgated a National Waste Policy in 2009 (EPHC, 2009) from which the Product Stewardship Act and the National Television Computer Recycling Scheme were drafted in 2011. Even though WEEE recycling increased successfully, many flaws were identified in the legislation which had to be reviewed in 2014 and 2015 (Morris & Metternicht, 2016:219). Since the introduction of the National Environmental Management: Waste Act 59 of 2008, the South African Government has not introduced any dedicated e-waste legislation. This is necessary as it will change over time, as has happened in Australia, to adapt to the South African scenario. The South African government is not to be responsible for any recycling funds, as these will end up in the coffers of the ruling party where it will be spent to drive political agendas; the purpose of receiving and spending recycling funds will then be defeated. Government can ensure through the schooling system that children get environmental education from an early age.

In the conceptual framework “Government” was identified as one of the actors in the e-waste recycling chain. The preceding sections highlighted the role of government in addressing the issue.

6.12 THEME 5: PRODUCER RESPONSIBILITY ORGANISATION (PRO)

In Figure 6.7, theme 5, the findings also addressed research question 1c: *What are the views of key stakeholders involved in the lifecycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?* The single category and associated codes included in this theme are interpreted in the following sections.

Figure 6.7: Research question 1c with related themes, categories and codes



Theme 5: The concept of a PRO is explored. Participants gave their opinions on whether such an organisation would be necessary in South Africa, and if it is necessary, how such an organisation should be structured.

6.12.1 Producer Responsibility Organisation (PRO) preferences and functions

Participants expressed positivism towards 1) a PRO steering the e-waste system, 2) a single PRO to handle all e-waste streams, 3) the involvement of many stakeholders, 4) an independent status for the PRO, and 5) the need for a registry that captures data from all relevant e-waste stakeholders. The following comments from participants reflect these ideas:

1) *“I think PRO’s is the given vehicle for extender producer responsibility. When industry would have some say in terms of the setup.” (P19SCM)*

2) *“When I look at a system where lighting now falls under its own jurisdiction and all sorts of bits and pieces, but it’s a critical and key integrated component of the e-waste cycle. So I believe that should all be under one PRO, but under that PRO you would then have divisions that would look at your white waste, your e-waste, your ICT waste, your lighting waste, and the new one that’s coming up is the solar waste.” (P1ES)*

3) *“Such as the PRO’s maybe, and maybe environmentalists ...yes environmentalists...It should include ... everyone should be part of this.” (P10GA)*

4) *“Proper PRO, completely independent, nobody can have any direct or indirect dealings to the actual recycling industry...” (P2ES)*

5) *“Setup with management of a registry to capture register, again I think that would fall onto the thing of a PricewaterhouseCoopers, because they will get the data from SARS and ITAC on import levels...” (P3ES)*

- ***In favour of a PRO steering the system***

This code votes in favour of implementing a PRO system in SA. The basic management and control functions are highlighted in this section.

The overwhelming majority of participants were of the opinion that a PRO for e-waste should be set up to take control of the management of e-waste activities in South Africa (P1ES, P2ES, P3ES, P4ES, P5GA, P9GA, P12GA, P14RDE, P16RDE, P18RDE, P19SCM, and P20SCM). Industry stakeholders should be on the board to ensure the system is under control, funds are spent appropriately, and there is no anti-competitive behaviour. Knowledgeable persons with no political undertones should thus run the non-profit PRO (P4ES and P18RDE). Developing a unique sustainable South African e-waste recycling model is thus crucial (P5GA) as the materials flow and disposal culture in a country, the ICT infrastructure, and the incentives all contribute to a responsive and sustainable system (Kahhat *et al.*, 2008:958).

The PRO must generate an income, spread e-waste awareness amongst the public, sort out logistics, and have transparent process where only legitimate recyclers can participate (P5GA, P14RDE, and P19SCM).

The PRO should assist government by being accountable for all the PRO functions and reporting to the Waste Bureau, the public and the rest of the stakeholders on e-waste streams (P1ES).

- ***In favour of a single PRO stream***

This code refers to the opinion that South Africa should have one single PRO to avoid competition, but sub-divisions within the PRO are preferred.

Participants opted for a single PRO which caters for all WEEE types (P1ES, P2ES, P3ES, P4ES, P5GA, P7GA, P9GA, P10GA, and P13GA), as South Africa is a small e-waste market and different PROs will cause management and administrative issues, as well as confusion and unnecessary competition (P1ES, P2ES, P5GA, P9GA, P10GA, and P13GA).

Although the call is to have one single PRO, the participants feel strongly about having divisions in the PRO which will look at different types of waste, such as white goods, ICT e-waste, lighting waste, and solar waste (P1ES, P3ES, P4ES, P5GA, P7GA, and P9GA).

- ***A PRO should involve many parties***

This code reflects the opinion that manufacturers, importers, recyclers, environmentalists and consumer watchdog bodies must all be part of the PRO to ensure transparency and accountability.

The PRO should be an independent NGO having a board that comprises different stakeholders having an interest in the whole recycling value chain (P1ES, P3ES, P9GA, and P10GA). The stakeholders should include manufacturers, producers, importers, distributors, OEM's, retailers, collectors, recyclers, e-waste associations, specialist advisors, environmentalists, etc. (P1ES, P3ES, P9GA, and P10GA). The board members must represent some association or group and thus have authority to make decisions on their behalf. Watchdogs such as OUTA, Safe South Africa, or Groundwork South Africa should be on the board as they would represent the consumers (P1ES and P3ES). Decisions made by the PRO could then be finally approved by the Waste Bureau as the Government body (P1ES).

- ***The PRO should be independent***

This code refers to the opinion that for the PRO system to work, the personnel need to be completely independent as they cannot be referees (rule makers and enforcers) as well as players (actively involved in industry).

A South African non-profit PRO needs to deliver and operate independently, without government interference (P1ES, P2ES, and P19SCM). The PRO must have the power to shut down any facility that operates in a way which can cause harm to the environment (P1ES). The best interest of the industry must be serviced and not the interest of the few, thus PRO personnel must not be involved with any of the industry stakeholders, especially recyclers. The refereeing function, such as awarding of collection, transport, and recycling contracts must be completely separated from the industry itself (P1ES, P2ES, and P19SCM).

- ***The need for a registry***

This code refers to the formation of a registry in which everyone involved with e-waste will be captured.

Participants stressed the importance of a registry that captures the data of all the relevant parties in the e-waste value chain. This must include all involved in manufacturing, selling, or distributing a product, such as producers, importers, distributors, retailers, collectors, recyclers, etc. (P1ES, P2ES, P3ES, and P8GA). A suggestion was given to capture information from importers by using the data from SARS and ITAC at the points of entry and to have them verified by auditing firms (P3ES). The history of the PETCO and POLICO (plastics recycling) PRO's has shown the importance of a registry as many producers are not contributing any money towards the recycling of plastics and are thus free riders of the systems (P1ES and P2ES). In this way all the different aspects of e-waste (products coming into South Africa, products sales, recycling numbers, refurbishing numbers, etc.) can be audited by independent auditors and be transparent to all stakeholders (P2ES).

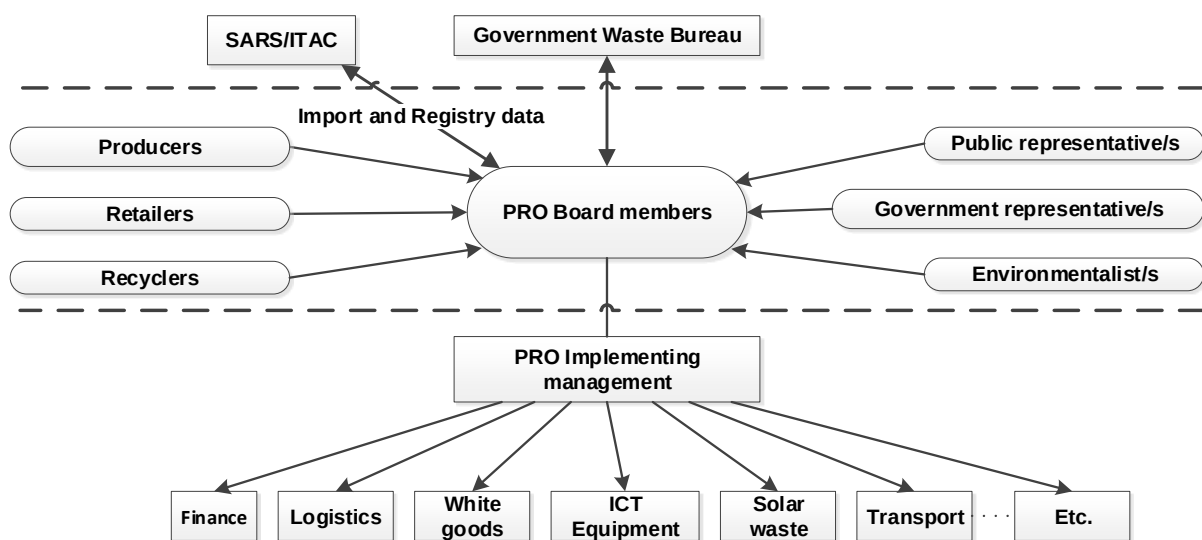
- ***Conclusion regarding PRO preferences and functions***

Figure 6.8 represents the single PRO who looks after all the different waste streams as suggested by participants. The PRO reports to the Waste Bureau, but the dashed line at the top indicates a definite separation and no direct involvement from the Waste Bureau into the PRO operations. The PRO board must consist of all the different stakeholders involved with e-waste, where each grouping will have a representative. Producers, recyclers, public representatives, environmentalists, etc., are shown as part of the board members of the PRO, but it is not limited to them. Other stakeholders, such as refurbishers, could be included in the mix. The PRO should function independently and should have powers that enable them to effectively run the e-waste sector. Closing of facilities and punitive measure powers should be given to the PRO to ensure compliance. All functions and the different e-waste streams should fall under the same single PRO. The bottom dashed lines indicate the separation of direct involvement from the PRO board with the implementing body of the PRO. The day to day operations must be done by the implementing body without any links between operational personnel and industry stakeholders. The link between SARS/ITAC and the PRO is indicated to establish a registry and could also represent the channel of reporting import figures and EEE items for capturing and auditing. In this way the recycling fee, which producers must pay can be established, sales figures will be reported, import weights would be known, and all importers of EEE would become part of a registry.

This registry can be used to involve members, but most importantly the registry will ensure there are no free-riders in the system, meaning they do not pay recycling fees. Free riding can be eliminated as non-payers of (previous) recycling fees can be prevented from collecting newly imported EEE items.

One of the sections of the conceptual framework refers to “Administering,” which refers to who should be responsible for the management and administration of e-waste recycling. Participants clearly indicated that a PRO should manage and run the e-waste management of urban household appliances.

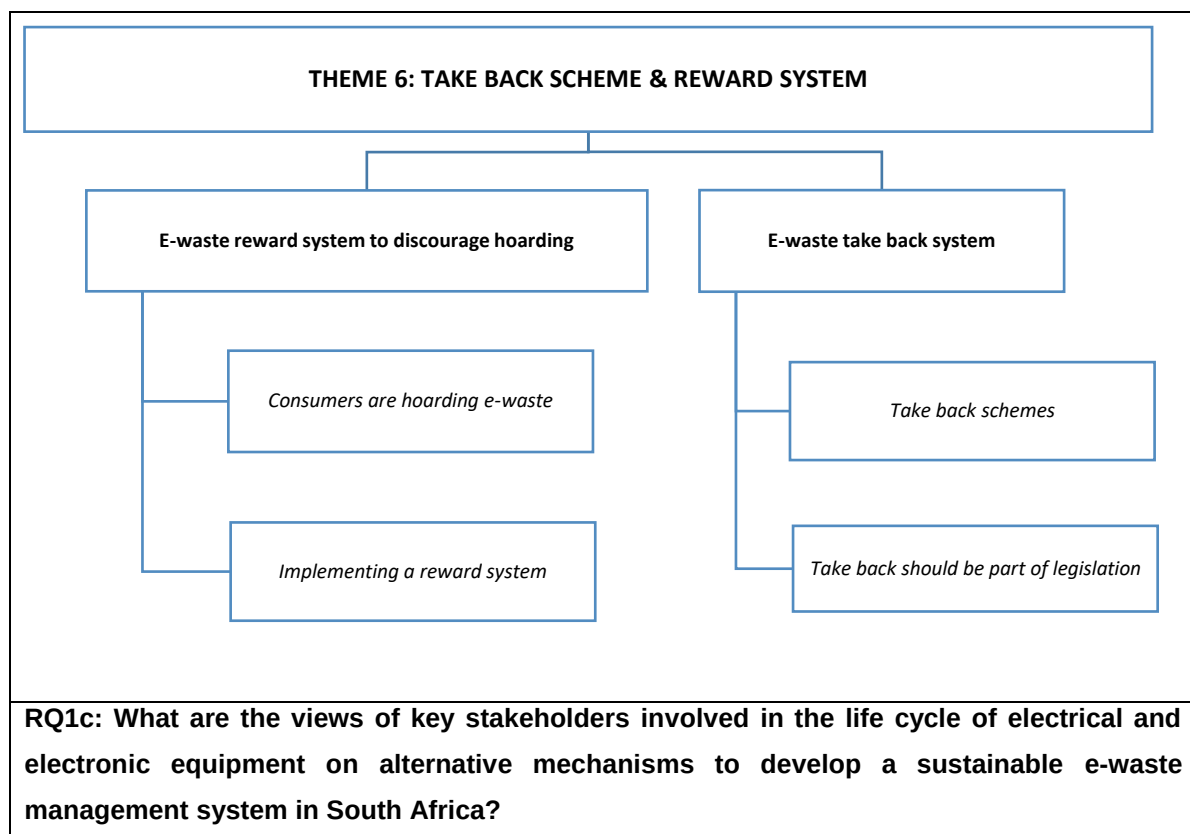
Figure 6.8: Proposed PRO setup and functioning



6.13 THEME 6: TAKE-BACK SCHEME AND REWARD SYSTEM

In Figure 6.9, theme 6 of the findings also addressed research question 1c: ***What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?*** The two categories and associated codes included in this theme are interpreted in the following sections.

Figure 6.9: Research question 1c with related themes, categories and codes



Theme 6: Take-back scheme and reward system relates to participant's opinions on the implementation of a take-back scheme and a reward system. Most participants were in favour of implementing a reward system, however several of them indicated that these rewards should not be cash based, but rather be in the form of loyalty cards or data.

6.13.1 E-waste reward system to discourage hoarding

The category points out that consumers 1) hoard e-waste for various reasons and, 2) participants are for and against a rewards system for various reasons, which will be discussed. The following extracts depict the contrasting views of the participants:

1) *"So where is the stuff? Very simply, it is still at the households."* (P3ES)

2) *"...a reward system needs to be in place, but I'm just not sure, we haven't had any successful examples of that with our other waste streams..."* (P7GA)

- ***Consumers are hoarding e-waste***

Consumers are reluctant to get rid of their e-waste, especially old cell phones and PCs, due to their perceived monetary value or attached sentiment. There is a need for education to break this mentality, or some sort of incentive that will drive consumers to release these stockpiles and recycle their e-waste.

Participants explained that old electrical and electronic devices are being stockpiled and hoarded at residences (P3ES, P4ES, P19SCM, and P20SCM). They believed that this was often due to sentimental value, significant money being paid for devices and the perception they are going to need it at some stage, or pass it down to someone, thus never getting rid of it (P1ES, P4ES, P16RDE, and P19SCM). This sentimental value mentality needs to be reduced using marketing efforts and by educating people to do the responsible thing and become part of a concerted effort to return e-waste (P1ES, P3ES, P16RDE, and P19SCM).

In higher income classes the planting of a tree would encourage consumers to return e-waste, whereas in rural areas consumers want something in return as they do not care about environmental consciousness (P3ES).

- ***Implementing a reward system***

Participants were in favour of implementing a reward system to kick-start recycling efforts of items, but concerns were raised about sustainability and the management of such a system. The participants in favour of a rewards system were also of the opinion that rewards should not take the form of a cash incentive.

Participants across the board agreed that consumers returning e-waste must be rewarded in some way (P1ES, P2ES, P3ES, P4ES, P5GA, P7GA, P8GA, P9GA, P10GA, P14RDE, P15RDE, P16RDE, P17RDE, P18RDE, P19SCM, and P20SCM).

There are however concerns about the sustainability of such a programme, the difficulty to manage such a system, the absence of similar systems around the world, and rural area complications, e.g. crime and accessibility (P1ES, P5GA, P7GA, and P9GA). Participants however still feel that a rewards programme must be introduced to kick-start

the returning of e-waste goods and once the desired behaviour is in place, to then cut back on the incentives (P1ES and P2ES).

Participants believed consumers, especially rural, want some reward to return their e-waste and that a cashless system should be implemented to collect all waste types using mobile collection units (P3ES, P5GA, P8GA, and P20SCM). This would encourage them to return stored goods and a perfect way to incentivise people and get them exited (P2ES, P3ES, P9GA, P10GA, P14RDE, P15RDE, P16RDE, P18RDE, and P19SCM). Several types of cashless rewards were proposed: i) credit or debit cards loaded with a monetary value (P3ES, P4ES, P8GA, and P20SCM); ii) a loyalty card where consumers could buy items from selected stores (Pick 'n Pay or Checkers), or from the store where the item was returned (P4ES, P5GA, P10GA, P14RDE, P15RDE, and); iii) offering a discount on a new item if a similar item was returned as e-waste (P2ES, P3ES, P12GA, and P14RDE); iv) mobile airtime or data as a form of payment (P3ES, P4ES, and P18RDE); v) payment in the form of a food or vegetable package (P10GA and P20SCM).

- ***Conclusion regarding an e-waste reward system to discourage hoarding***

E-waste is stored and later disposed through the normal rubbish bins or to landfills by persons who have access to pick up vehicles. A similar situation is experienced by Indian consumers, where 75% of items are stored for the same reason (Saritha, Sunil Kumar & Srikanth, 2015:39). Consumers hoard e-waste items due to sentimental value, and possible later use. The researcher is also of the opinion that the South African consumers hoard e-waste as they are uncertain what to do with the items. All consumers need to be educated by the PRO on the dangers associated with e-waste, as well as the low values of e-waste. South Africa is a low-income country, with a yearly disposable income per capita of 6323 USD, has an unemployment rate of 24.4%, and 50% of the population lives below the poverty line. The consumer expenditure per capita on household goods and services (includes electrical equipment, fridge, freezers, etc.) is 27 USD/year, which is very low compared to other countries. Household goods are thus not replaced regularly, and it is used until it cannot be repaired (World Consumer Income and Expenditure Patterns, 2013). With South Africa being amongst the poorer countries in the world, one can safely assume that consumers have some attachment to EEE and even WEEE, and that they regard WEEE as items having some form of monetary value.

Participants were all very vocal and insisted on a reward system, financially or otherwise, to initiate the process. Consumers, especially rural, would support a reward for returning e-waste, as these people have low incomes and this would be the only way to limit hazardous practices where e-waste ends up in landfills. A similar attitude is found in India, where consumers would rather sell e-waste to collectors than adhere to EPR principles (Borthakur & Govind, 2018:1056). Rewards should never be in the form of direct cash payments as this would lead to crime.

6.13.2 E-waste take-back system

Participants are, 1) in favour of a take-back scheme for retailers and 2) insist on legislation which enforces it. The following extracts depict the contrasting views of the participants:

1) “Ja, definitely your outlets where you purchase the stuff, because that’s the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you’re buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what’s ... ja.” (P16RDE)

2) “With legislation it should be part of the law, because if you don’t do it, then it will not be controlled, it can also become a mess, but yes, like you said, go back to your Games and these places and we can take it back, but yes, again, and I’ve seen that many times with programs like this gets implemented, you know everybody brings it, or the shop takes it back, but at the back of the store it just goes into the normal waste bin again.” (P18RDE)

- **Take-Back schemes**

Some participants were in favour of implementing a take-back scheme, but there also those who were opposed to the idea. In the code called “Current and potential allocated drop-off points,” under category 6.5.2, participants indicated that retailers collecting e-waste would be a place of convenience for consumers. This code however describes the importance of a take-back system with regard to producer and retailer involvement.

Participants are in favour of retailers taking back old equipment similar to what they sell, as part of EPR and getting producers involved with the initiative (P2ES, P3ES, P4ES, P5GA, P10GA, P12GA, P14RDE, P16RDE, and P18RDE). Producers and retailers must be collaboratively involved as they are the knowledgeable persons on their own equipment and ultimately everyone will benefit (P5GA, P10GA, P12GA, and P16RDE). Take-back initiatives should be in place throughout the year and not run for short periods (P14RDE). For new LDA purchases the retailers must collect and store old equipment free of charge (P3ES).

Concerns raised were that retailers sell items but are not trained to collect e-waste (P10GA), and that e-waste could possibly get dumped in waste bins after being received (P18RDE). The retailer participant however expressed a different view on this topic. He would rather avoid taking back e-waste as he is not sure what to do with it, does not have space to store the items, shopping mall storage space is very expensive, and record keeping of received items would be difficult as they are already overloaded with statutory required administrative feedback (P20SCM).

- ***Take-back should be part of legislation***

This code refers to the opinion that take-back programmes should be required by law. Participants are of the view that the retailer must have a legal responsibility to receive e-waste and the household consumer must also be legally bound to take back e-waste to some collection point or to the retailer. Retailers should be legally forced to keep registers of received e-waste to ensure an audit trail is possible for e-waste coming in and going out (P3ES and P18RDE).

- ***Conclusion regarding an e-waste take back system***

Retailers are the direct link between consumers and e-waste and the important role of retailers is obvious. EEE retailer setup varies and whereas some have ample space for storage, as well as administrative capabilities and capacity, others have limited storage space and/or limited administrative support. The current Second-Hand Goods Act (6 of 2009) requires that detailed documented proof is needed on site of WEEE being collected at retailers. The act further specifies that equipment being collected in this way must be kept in store for at least 7 days. This act would be problematic for the retailers with storage and administrative restrictions.

Legislation should require retailers to accept e-waste items similar to those they sell, but those with special permission should be exempted from the legislation. All retailers must however:

- Educate and motivate customers to return e-waste.
- Get guidance from producers to effectively and safely store returned e-waste.
- Distribute contact information on call-to-collect information to dispose of LDA's.

Retailers with available storage space and enough administrative capabilities must:

- Take back similar type e-waste as is sold in their stores.
- Inform the PRO when the returned e-waste has reached a specified volume.
- Inform the PRO of the weights and numbers of collected items.
- Administer a rewards programme for returned items.
- Have record keeping, such as items and weights received, to prevent illegal dumping and to enable auditing.

In cases where retailers have small outlets, operate in a shopping mall (small area and costly) or have limited administrative capacity the retailers should:

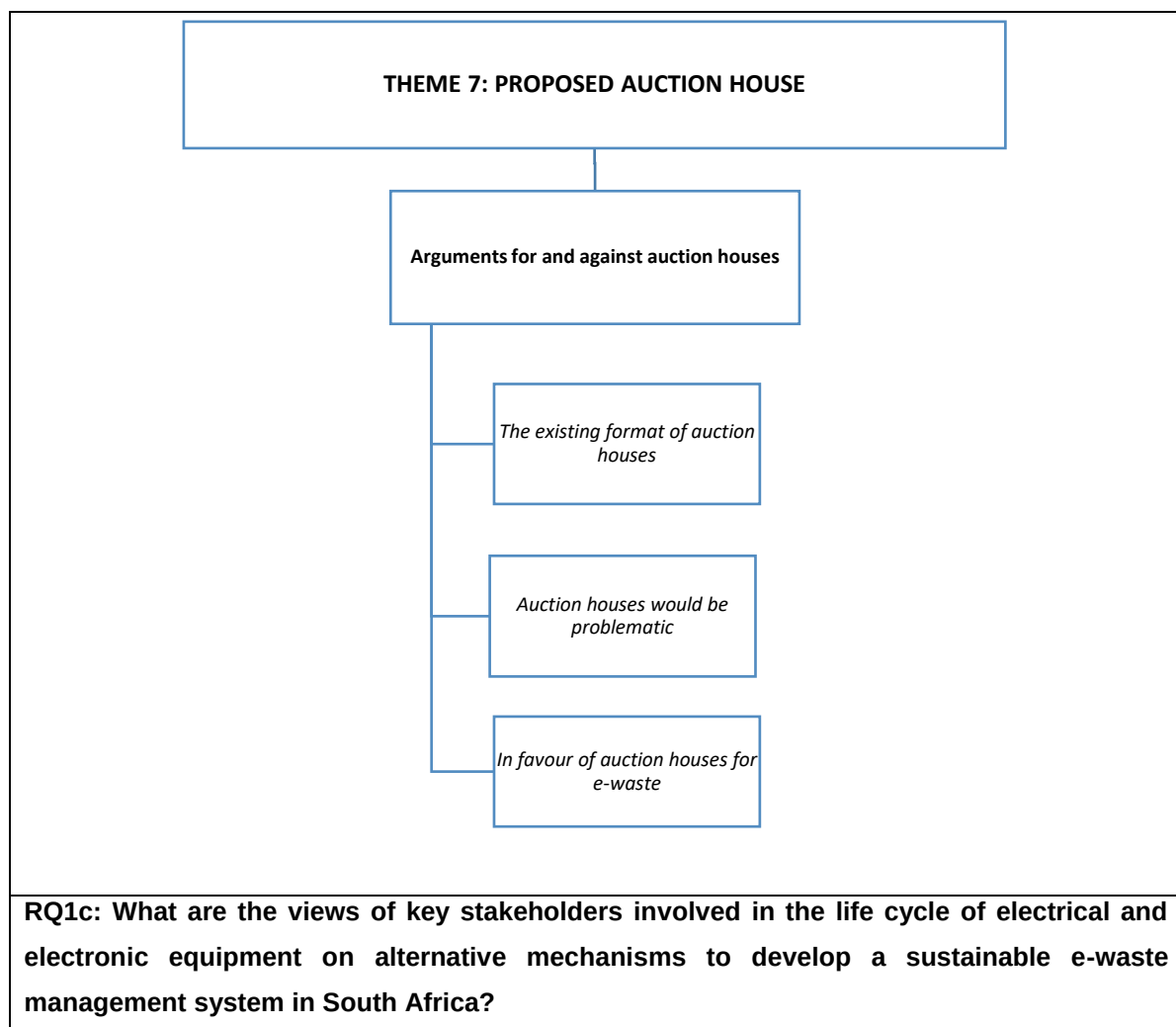
- Get approval from the PRO to not store/receive e-waste at their premises.
- Direct consumers to collection points close to the outlet or the PRO should arrange to place a collection container at the mall.

Legislation should be promulgated to force mall owners and mall management to allow the placement of an e-waste container on the premises where enough EEE items are being sold, e.g. if 30% of the mall tenants sell EEE items, or 20% of the floor space is occupied with EEE retailers.

6.14 THEME 7: PROPOSED AUCTION HOUSE

In Figure 6.10, theme 7 of the findings also addressed research question 3: ***What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?*** The single category and associated codes included in this theme are interpreted in the following sections.

Figure 6.10: Research question 1c with related themes, categories and codes



Theme 7: Proposed auction house evolved around an idea for the implementation of an auction house as a central point of collection, basic separation, and distribution towards refurbishing and recycling was introduced to participants. Different views regarding the effectiveness/implementation of such an auction house were expressed.

6.14.1 Arguments for and against auction houses

In this category participants gave feedback on, 1) how e-waste is currently auctioned off or bidding takes place, 2) perceived auction house problems, and 3) favourable perceptions regarding auction houses. The following extracts depict the perceptions and contrasting views of the participants:

1) *“But you see now here’s a challenge, is that we have a system, and the system goes outside by getting a service provider to buy the material. We’ve got different service providers that’s bid for that. Now when you compare that with what you are asking while you have to go out, is that there is already people out there, small men, that goes to companies that says; I need your laptops” (P13GA)*

2) *“Ja, it could be a concept that could be looked at, but from an extended producer responsibility point of view, ja, you would create a trading platform, and currently, I mean, if you look at this type of trading platforms being applied by the public sector, it fails dismally.” (P19SCM)*

3) *“It definitely could work, ja, it’s interesting, it could work definitely.” (P16RDE)*

- ***The Existing format of auction systems***

Participants indicated their experiences and current practices of how companies and Government disposes of their e-waste. Auctions and tenders are used and the flaw in the system is highlighted.

Municipalities replace older equipment regularly, which implies that the equipment is still in working order or can be reconditioned. The equipment is then placed on tender or auctioned to prospective buyers (P11GA, P12GA, and P13GA). Government works on the same principle, and the problem with this approach is that the wrong persons or group (can) get access to the old equipment as there are no strict regulations on the people being allowed to be part of the auctions (P3ES and P19SCM). There was a concern around cherry picking, which happens after buyers get hold of e-waste from public auctions as there is no control after the sales occurred and it fails dismally (P7GA and P19SCM).

- ***Auction houses would be problematic***

This code refers to participants who were wary, for a number of reasons, of the idea of creating auction houses to sell e-waste to recyclers.

The control and management of the system itself to ensure an open, fair, transparent, and competitive system could be problematic (P1ES, P14RDE and P19SCM). An auction house would require experts when separation is done, which could be another hurdle (P15RDE). Participants see the setting up of an auction house as the addition of an extra leg in the reversed logistics chain, which could lead to a monopoly (P1ES and P2ES). One suggestion was to not have a central auction house but to have a materials recovery facility in certain regions, which would add to job creation (P2ES).

- ***In favour of auction houses for e-waste***

These participants were in favour of the proposed idea of implementing auction houses for, 1) the accumulation of e-waste at a central point, 2) the basic separation of e-waste into different streams, and 3) for the auctioneering and distribution of e-waste to only approved recyclers.

Participants believed the auction house suggestion could work (P3ES, P4ES, P8GA, P10GA, P14RDE, P16RDE, and P18RDE). The consensus was that only approved recyclers or refurbishers, who were registered to handle specific e-waste streams, would be allowed to bid at the auction (P8GA, P10GA, and P18RDE). An auction house would require more logistics and tight control by a PRO but downstream inefficiencies could be reduced (P3ES, P4ES, and P14RDE). Basic separation at the auction house would add value to e-waste, and recyclers and refurbishers would get more value for their money (P4ES and P16RDE).

- ***Conclusions regarding arguments for and against auction houses***

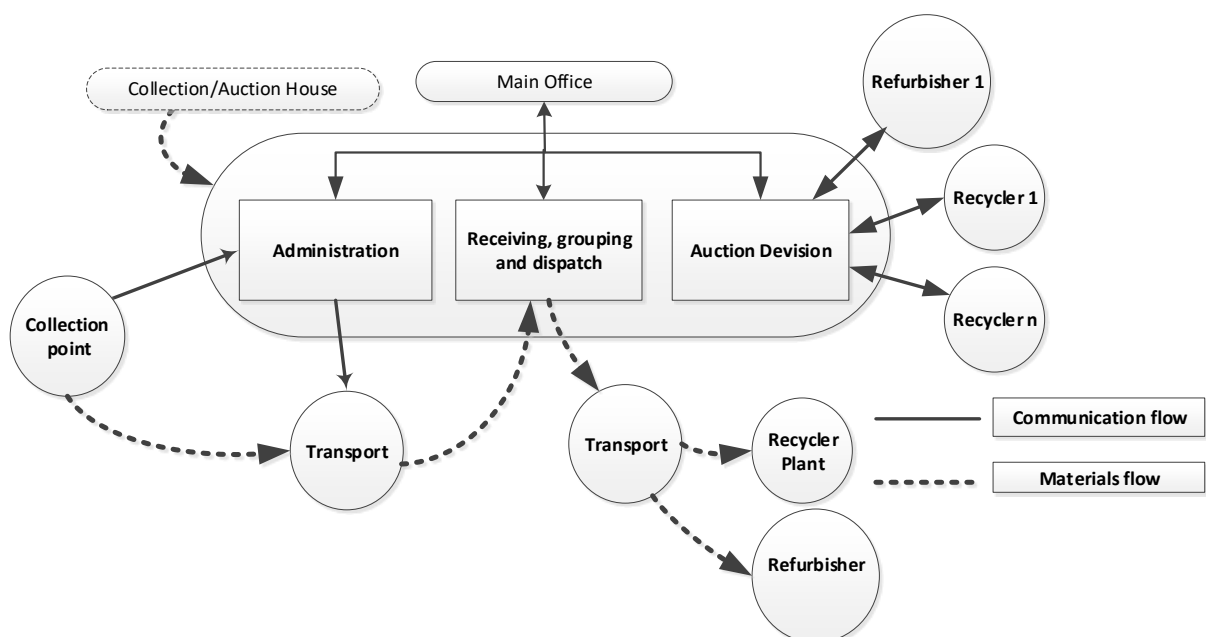
As an introduction, the concept of an e-waste auction house must be explained. During the interviews, vignettes were used to introduce the concept and to test the opinions and perceptions of participants. The auction house, which would be producer driven, would have the function of collecting all the e-waste from collection points, transporting it to the auction site, separating the e-waste into different streams, and to then auction the e-waste streams to accredited e-waste recyclers who specialise in the different streams. The highest bidder will thus buy, collect, and transport the waste to their own facility. In the event of transport of non-viable items, the auction house/producers will have to cover the financial costs of the transport.

Producers should pay for the transport arrangements from a collection point to the auction house; this option was explored as auctions are economic environments, which are well-defined and simple to operate (Klemperer, 1999:227).

Participant's background around auctioning systems is related to the current method of operation. In most municipal systems items are auctioned off to the highest bidder, irrespective of their capabilities to recycle; this can lead to cherry picking and dumping. Those wary of an auction system foresee management and control problems in ensuring a transparent and competitive system. The use of experts when separation is done was seen as another hurdle and leg in the reversed logistics chain, which could lead to a monopoly. The majority of the participants were in favour of implementing an auction house system, especially if only approved recyclers were allowed to bid at the auction. Tight control by the PRO could eliminate or reduce downstream inefficiencies. The separation into the different e-waste streams would add value to e-waste recyclers and refurbishers.

Figure 6.11 depicts the proposed collection and auction house. Two different flows, namely that of information (the solid line) and material flow (the dotted line) are shown. The auction house could consist of three sections: the administrative department, the receiving/grouping/dispatch group, and the auctioning section.

Figure 6.11: Proposed Collection and Auction house



- The **administrative section** should be the centre point of information. When a collection point, such as a retailer/garden refuse site/drop off point, has reached capacity the administration department must be informed. LDA collections could also be arranged through this department who would then inform the transport company, which in turn must do the collection. The department must ensure that municipalities communicate contact details of the auction house as well as collection arrangements in smaller municipalities to the public. This department should also give feedback to the PRO on the number/weights of received WEEE and the income generated (or liable to recycler) through the auctioning of WEEE. It should handle the reception of money for positive value WEEE being auctioned, payments to recyclers for negative value WEEE, and receive feedback from recyclers on the weight of fractions being recycled.

- The **receiving, grouping and dispatching section** must receive the collected WEEE from the transport department. As the received WEEE items will be mixed, they should separate the WEEE and group them in different categories. The concern about the need for experts is positive, as items can be grouped in different categories and those that are recyclable can be identified and separated from the rest. When comparing data from EU countries, Romania compares realistically with the South African situation (World Consumer Income and Expenditure Patterns, 2013). The lifetime of EEE use in Romania is almost double that of other EU member states (Torretta *et al.*, 2013:118-120). Through the auction house system, items that are still in a condition to be refurbished will be separated from recyclable WEEE to be sold to second-hand goods dealers. In this way the EoL of the items can be extended to a later date.

- The **auction section** should deal with the auctioning of the WEEE. Dates and details of WEEE material to be auctioned must be published through the administration department. On auction days this section must ensure that bidders are registered, auction deposits are collected, terms of the auction are communicated, an auction list with available items is distributed and details of buyers of lots are captured.

An auction house as proposed would have advantages in the form of:

- Collection and transport arrangements would be coordinated.
- Optimal collection would be achievable as the transport company/section would collect all the WEEE at the collection points. By using an optimal size vehicle, transport costs and vehicles on the roads would be minimised.
- After separation at the auction house, recyclers can focus on the item lots for which they have licenses to recycle.
- Lots for refurbishment would prolong the life of EEE.
- Registered recyclers would have a fair and equal chance when bidding for items.
- Tender fraud would be eliminated as the auctioneering of materials would be a transparent process.
- Payments received from recyclers or paid to recyclers would be done over short periods, as transactions and the removal of the WEEE would need to happen before the next auction (Petersheim & Longenecker, 2015).
- Data of fractions being exported or recycled on the local market would be available to the managing PRO entity and government for monitoring progress or deviations from set targets.
- An auction house system would rather prevent cherry picking and dumping and better management and control is foreseen.

Auction houses can thus form part of the PRO and ultimately be the centre point of collection, separation, auctioning and be the information and administration hub of the management system. Irrespective of whether the auction house is going to be the preferred method of operation, the comments from participants still point towards a central collection and separation site from where collections and distribution to recyclers could be effectively arranged. With control and proper management, the incoming and outgoing e-waste could be quantified at a central point and reporting back from the recyclers/refurbishers would be monitored effectively, ensuring an open, fair, transparent, traceable, and competitive system, which would eliminate cherry picking and ensure there was no monopoly.

It was proposed that these auction houses be placed in the bigger cities/towns in South Africa. Recyclers are currently found around the bigger cities, such as Johannesburg and surrounding areas, Cape Town, and Durban/Ballito/Pietermaritzburg areas. It should be strategically placed around recyclers to ensure that the distance from an auction house to a recycler is no more than 300 km round trip. In the research of Barba-Gutierrez, Adenso-Diaz and Hopp (2008:494), it was shown that the environmental and economic advantages become negative if the total distance to travel from a collection point to the recycler was more than 300 km. Due to the fairly large distances between cities in South Africa, it would not be possible to have all collection points and auction houses within the 300 km round trip radius; the solution would be to have collections at remote areas done less frequently and with larger trucks to ensure single trips and economy of scale. A single trip per year or twice per year to collect WEEE in rural areas and to transport it to the bigger cities would be needed to ensure effectiveness. In the smaller towns, transportation from the collection points should happen more frequently than compared to rural areas, e.g. once a month or once every two months. The time periods between transportation could only be determined if implemented.

Although the concept of an auction house was not pertinently indicated on the conceptual framework, many of the sections/functions overlapped with the concept. Should the management framework be implemented in a pilot study, it was suggested that the auction house concept be also tested for functionality.

- **Conclusions regarding Research Question 1c**

RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

To answer this final qualitative research question, the experiences and views of key stakeholders on alternative mechanisms to develop a sustainable e-waste management system for household e-waste in South Africa were analysed. Participants indicated a preference for EPR to address household e-waste. The intersecting roles of the different stakeholders were highlighted, as well as an urgent need for legislation to implement EPR. The importance of education of the consumer was also discussed.

To ensure a sustainable system the funding of the EPR programme is essential, and the initiator role of Government, the funding role of the producers, the preferred method of collection, and the views on the visibility of the fee were discussed. Serious shortcomings in some recycling facilities, as well as the need for refurbishing centres, were revealed and the role of Government to address the situation were analysed. The mistrust in Government, corruption, and their historical inability to address recycling needs showed, therefore there is an urgent need for a transparent system managed by an independent e-waste PRO. Suggestions of the preferred PRO format, as well as who should be involved in the PRO board, were given and discussed. The importance of an independent operational section of the PRO, who has no industry links were communicated as not negotiable by participants. To ensure the involvement of all stakeholders, a registry was suggested as this would be the only way to curb free riders. Consumers as the legal owners of e-waste need to be encouraged to separate their e-waste and a rewards programme to initiate the process was proposed, especially for the rural areas. Retailers as a take-back point, information centre, and the challenges faced by them highlighted the role of this sector.

The section concluded with a detailed discussion of a proposed auction house. Although some participants were against the proposal the majority of the participants were in favour of the concept, as many aspects of what is needed to manage the e-waste system could be addressed. This would include the arrangement of transport to collection points, collection of LDA's, separation into refurbishing and other streams, the distribution to recycling facilities, and an auditable system from which government could receive numbers of recyclable fractions. The research question thus received detail answers and suggestions from participants which, if implemented, would contribute immensely to the development of an effective management model for South African household e-waste.

6.15 CONCLUSION

Chapter 6 started with an introduction of the background of the researcher and the co-coder. This was followed by a detailed description of the participants who participated in the study through the interviews. One Atlas.ti figure was given to indicate that the mentioned software was used for the analysis of the transcriptions. During the analysis of the transcripts a total of 39 codes, 16 categories, and 7 themes were extracted. In the

chapter the qualitative research questions were answered by linking the extracted themes and categories to the question. The themes and categories gave insightful solutions and proposals of what should be incorporated to make a South African e-waste management system viable. In Chapter 4 and 5 the quantitative conceptual framework and methodology was discussed. The data which were obtained in the quantitative consumer survey will be discussed in Chapter 7.

CHAPTER 7- RESULTS OF THE QUANTITATIVE RESEARCH PHASE

7.1 INTRODUCTION

In this chapter, the demographic composition of the respondents will be discussed, followed by an analysis of the descriptive data. The reliability tests, which were conducted on the factors/constructs, will be discussed followed by the analysis of T-tests, Anova tests, hypothesis testing using SEM, and lastly, the final proposed model will be presented.

7.2 RESPONSE RATE AND CHARACTERISTICS

The questionnaire for the qualitative research phase was distributed through a research house to people living in urban areas and more specifically, in the large cities in South Africa. The distribution was done electronically, and 522 persons completed the questionnaire.

SPSS Version 24 statistical software was used to analyse the data. Respondents were not forced to choose an option for a question before allowing to complete the next question. This resulted in some questions not being answered. For this reason, the number of respondents (n) were not always equal to 522. Valid percentages were used in the descriptive data tables, thus ignoring the number of respondents who opted not to answer a question. The question related to the income was not answered by 15 respondents (2.8%). This non-completion of the question was to be expected since people often do not want to disclose their income. The missing answers to other questions were much lower. A statistically significant sample was thus obtained from which reliable interpretations could be made.

All respondents older than 18 years were invited to complete the survey. Just by completing the survey, the respondents had to have access to electronic devices, which will also become e-waste at some point. Almost every person of 18 years and above could contribute to the study, as electronic devices are an integral part of everyone's daily life.

7.3 DEMOGRAPHIC PROFILE OF RESPONDENTS

The demographic profiles of the respondents are described in this section to understand the representation of the respondents who participated in the survey. The profiles included gender, age, income, education, home language, and city of residence.

Table 7.1 and Figure 7.1 confirm that there is a relatively equal distribution between males and females. From the 522 respondents, males had a slightly higher representation (52.9%); four (or 0.8%) did not indicate their gender.

Table 7.1: Gender distribution of respondents

Gender	n	%
Male	276	52.9
Female	242	46.4
Not Indicated	4	0.8
Total	522	100

Figure 7.1: Question 39- Male/female composition of respondents

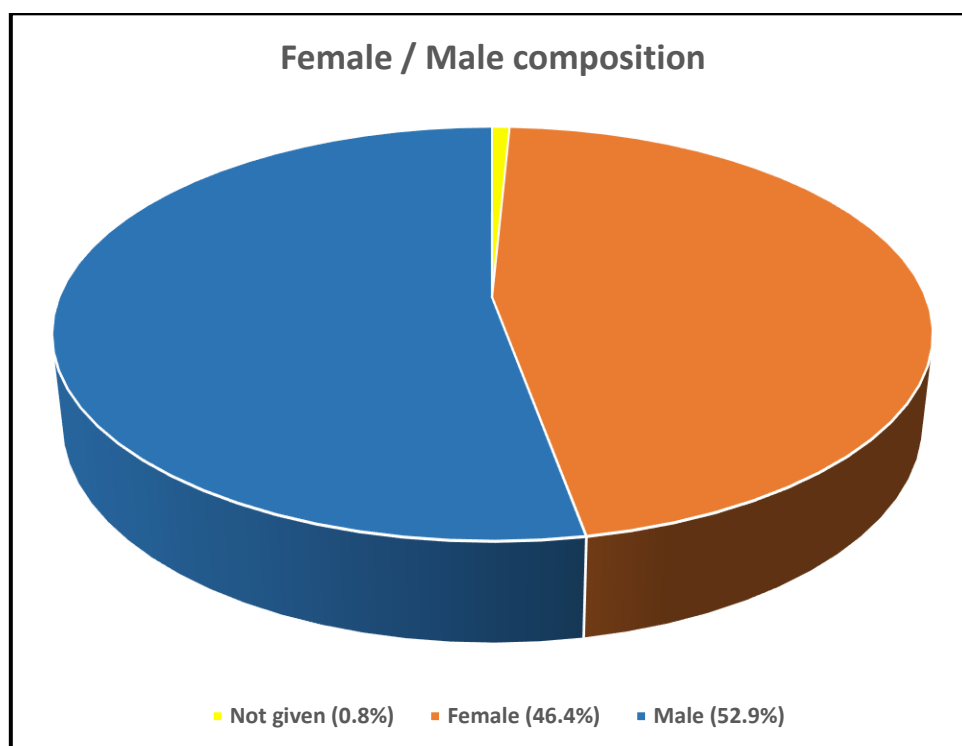


Table 7.2 and Figure 7.2 indicate the distribution of the age of the 522 respondents. The majority of respondents were 50 years or older (52.5%), followed by those who are 35 to 44 years (20.3%).

Table 7.2: Age distribution of respondents

Age	n	%
18 to 24 years	24	4.6
25 to 34 years	47	9.0
35 to 44 years	106	20.3
45 to 49 years	71	13.6
More than 50 years	274	52.5
Total	522	100

Figure 7.2: Question 40- Current age distribution of respondents

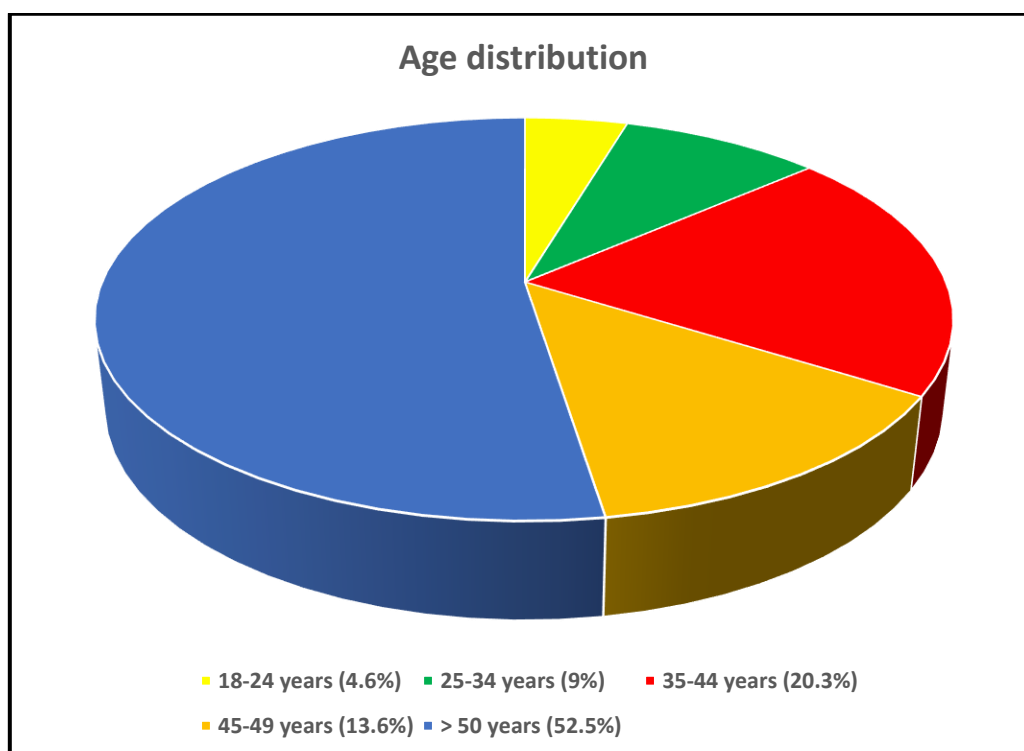


Table 7.3 and Figure 7.3 indicate the cities where respondents resided. Johannesburg and Ekurhuleni accounted for more than 30% of the respondents, while Pretoria, Cape Town, and Durban accounted for more than 40%. Respondents from Mid-sized towns were 12.1% and included reasonably sized cities such as Bloemfontein, East London, George, Port Elizabeth, and Pietermaritzburg. These Mid-size towns, having similar structures to large cities, can be placed in the same categories where e-waste recycling is concerned. More than 80% of the respondents were from large metro cities or reasonably sized cities. The focus of the current study was on large urban areas and the sample received thus fit the profile of the targeted population.

Table 7.3: City of residence of respondents

City	n	%
City of Cape Town (15.3%)	80	15.3
City of Johannesburg (22.6%)	118	22.6
Ekurhuleni (8.6%)	45	8.6
EThekweni-Durban (7.5%)	39	7.5
Tshwane-Pretoria (18.4%)	96	18.4
Mid-size Towns (12.1%)	63	12.1
Small Towns (6.1%)	32	6.1
Not indicated (9.4%)	49	9.4
Total	522	100

Figure 7.3: Question 41- Respondents' city of residence

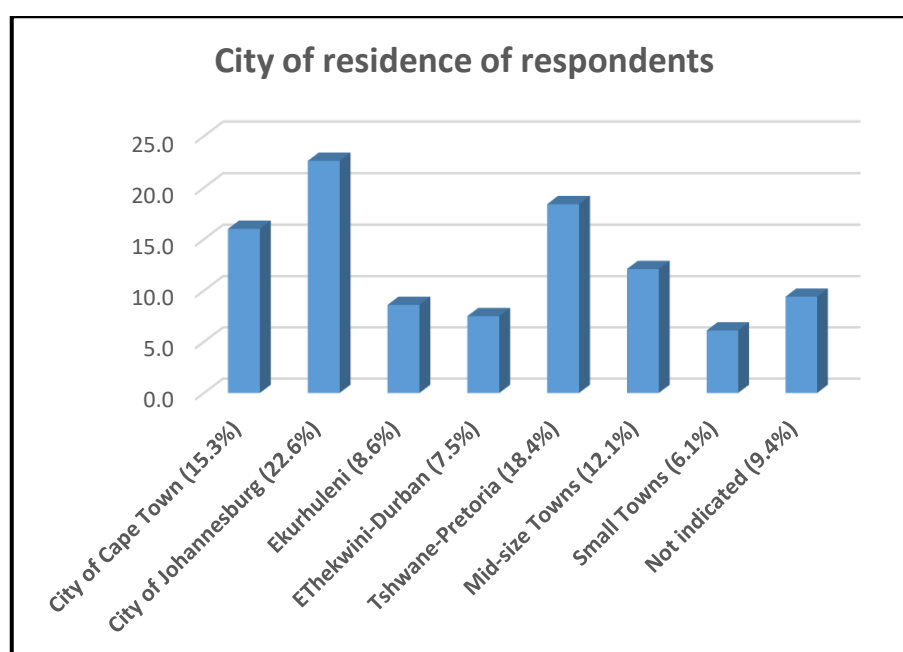


Table 7.4 and Figure 7.4 reveal that most incomes groups are distributed in a Bell curve. The exception is the 20.7% of the 522 respondents that earned more than R 76 801 per month.

Table 7.4: Income of respondents

Income	n	%
Less than R6401	41	7.9
R 6401 – R 12800	44	8.4
R12801 - R25600	79	15.1
R25601 – R38400	78	14.9
R38401 – R51200	74	14.2
R51201 – R64000	43	8.2
R64001 – R76800	40	7.7
R76801 or more	108	20.7
No indication given	15	2.9
Total	522	100

Figure 7.4: Question 42-Respondent's monthly income before deductions

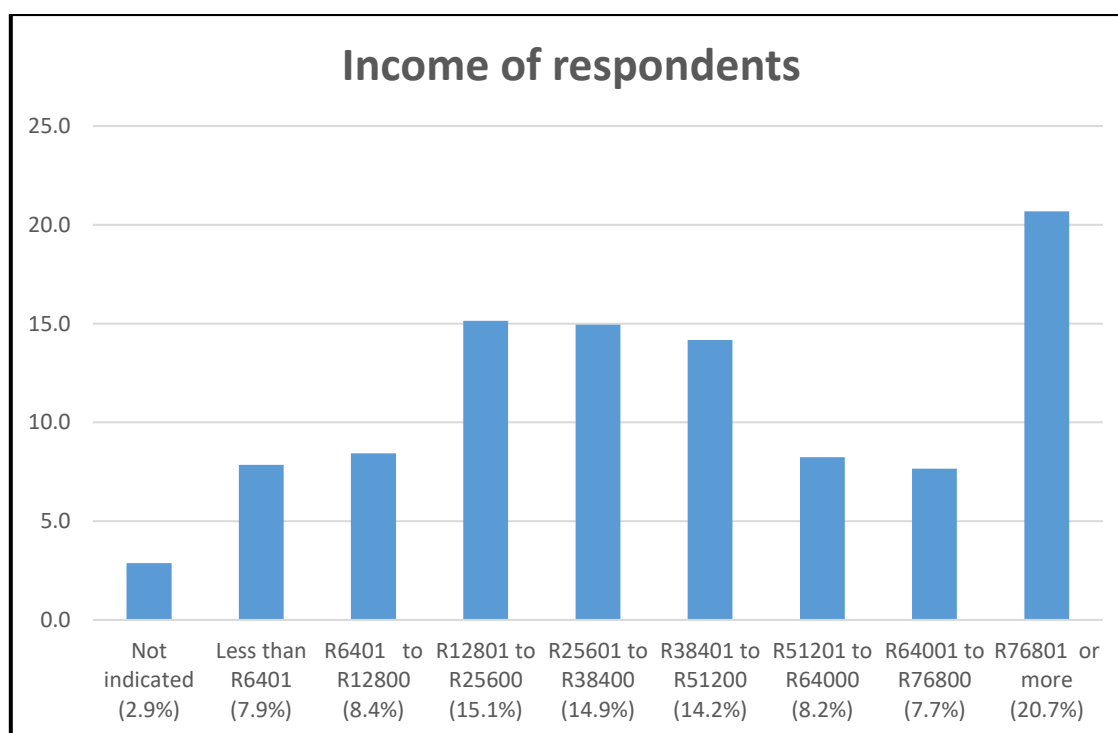


Table 7.5 and Figure 7.5 show that the majority (83.4%) of the 522 respondents had some form of post-school qualification. Most of these respondents (43.9%) had a Diploma/Degree/B-Tech as qualification.

Table 7.5: Education level of respondents

Education	n	%
Grade 1 to 11	7	1.3
Grade 12	71	13.6
Diploma/Degree/B-Tech	229	43.9
Honours level Degree	108	20.7
Masters/PhD Degree	98	18.8
Not indicated	9	1.7
Total	522	100

Figure 7.5: Question 43-Respondents' education level

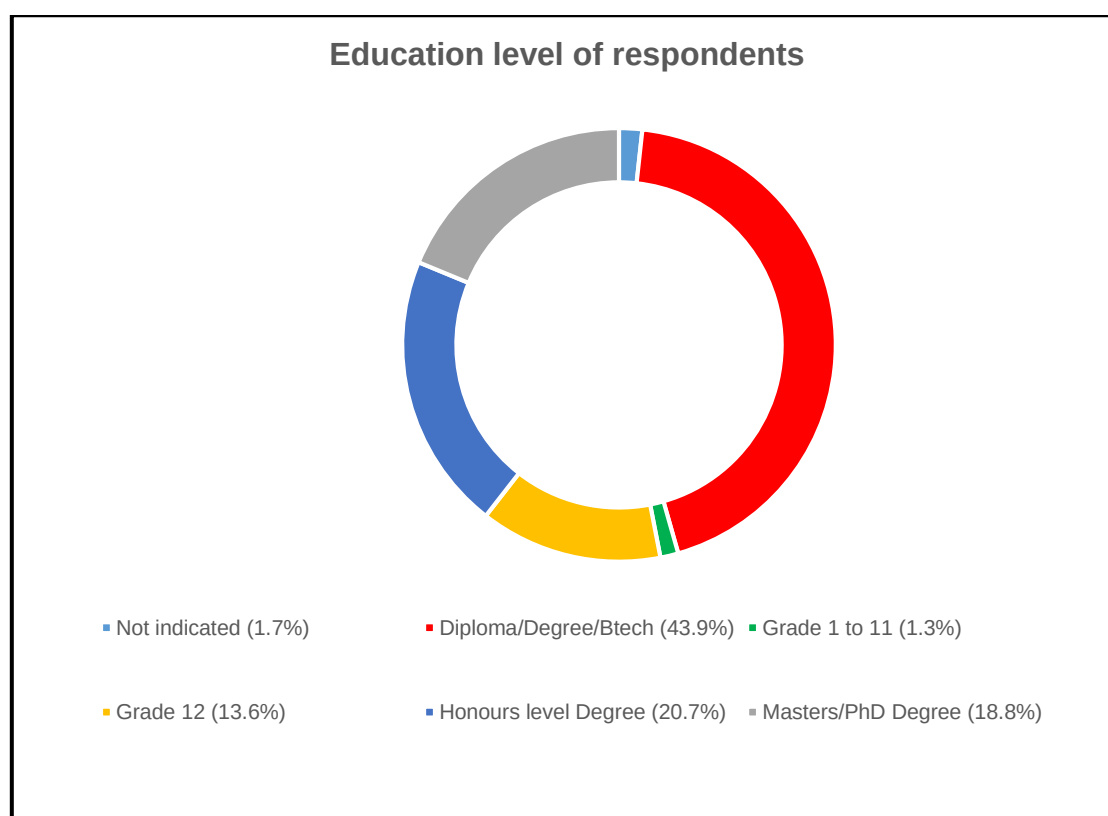
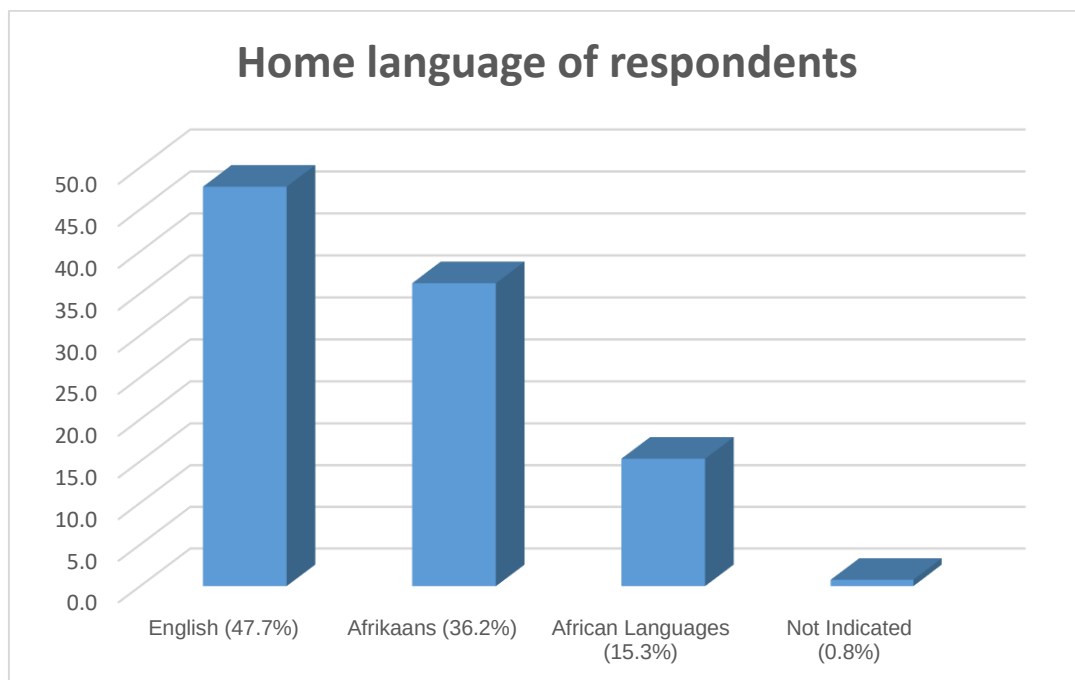


Table 7.6 and Figure 7.6 indicated that the majority (47.7%) of the 522 respondents spoke English as home language. A large portion (36.2%) spoke Afrikaans, the African language respondents equalled 15.3%, and 0.8% did not indicate their home language.

Table 7.6: Language spoken by respondents

Language	n	%
English	249	47.7
Afrikaans	189	36.2
African languages (15.3%)	80	15.3
Not Indicated	4	0.8
Total	522	100

Figure 7.6: Question 44-Respondent's home language



7.4 DESCRIPTIVE STATISTICS

The following tables specify percentages distribution of the questions under the respective constructs in the questionnaire. The Likert scale values indicated the extent to which the respondents agreed or disagreed with the statements with regard to the different questions on a five point scale.

Table 7.7 reflects the distribution of the responses received. Environmental awareness refers to the consumer's environmental consciousness. The high mean values (4.4 to 4.76) for questions 1 to 3 (EA1 to EA3), gave a clear indication that the respondents were concerned about environmental issues, were of the opinion that consumers' daily habits can affect the environment, and believed everyone should contribute to protect the environment. The standard deviations for question 1 is higher (SD=0.98) than for question 2 (SD=0.58) and question 3 (SD=0.55). This suggests that the respondents differ more in terms of environmental issues than the opinion that consumers' daily habits can affect the environment and that everyone should contribute to protect the environment.

Table 7.7: Descriptive statistics of environmental awareness

ENVIRONMENTAL AWARENESS (EA)					
Item statements					
No	Indicator	Question	n	M	SD
1	EA1	I am often concerned about environmental issues.	506	4.40	0.77
2	EA2	I think that our daily habits can affect the environment.	503	4.70	0.58
3	EA3	I think everyone should contribute to protect the environment.	509	4.76	0.55
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
EA1	0.6	1.2	10.3	34.0	54.0
EA2	0.4	1.0	1.0	23.5	74.2
EA3	0.6	0.4	1.2	18.5	79.4

Table 7.8 indicates the distribution regarding the attitude towards e-waste recycling which refers to the perceptions from consumers on environmental protection via e-waste recycling. From the high mean values (3.88 to 4.71) for questions 4 to 10 (ATR1 to ATR7) it is clear that the respondents are prepared to participate and support the setting up of systems to recycle e-waste effectively, as that would reduce pollution. On question 5 (ATR2), 18.8% responded neutral. This could be attributed to the fact that respondents were aware of positive effects of informal recycling of paper and plastics, but unsure of the negative effect of informal e-waste recycling. The standard deviation for Question 5 is higher (SD=1.13) than for the other questions, suggesting that the respondents differ more in terms of this issue compared to the other items.

Table 7.8: Descriptive statistics of attitude towards e-waste recycling

ATTITUDE TOWARDS E-WASTE RECYCLING (ATR)					
Item statements					
No	Indicator	Question	n	M	SD
4	ATR1	I believe that recycling of e-waste can reduce environmental pollution.	514	4.71	0.59
5	ATR2	I believe that informal recycling of e-waste can pollute the environment.	517	3.88	1.13
6	ATR3	I believe that recycling of e-waste can protect the use of natural resources.	516	4.58	0.63
7	ATR4	I would like to contribute to the reduction of harmful e-waste.	517	4.60	0.65
8	ATR5	I believe that all households should voluntarily participate in e-waste recycling.	513	4.60	0.66
9	ATR6	I support initiatives that aim to set up an organised e-waste collection system.	516	4.61	0.66
10	ATR7	I support initiatives that aim to set up an organised e-waste recycling system.	513	4.61	0.64
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly	Disagree	Neutral	Agree	Strongly
ATR1	0.4	0.2	4.1	18.7	76.7
ATR2	2.9	11.6	18.8	28.2	38.5
ATR3	0.4	0.2	4.7	31.0	63.8
ATR4	0.4	0.8	4.4	27.1	67.3
ATR5	0.6	0.6	4.7	26.5	67.6
ATR6	0.6	0.4	5.0	25.2	68.8
ATR7	0.6	0.2	4.5	27.5	67.3

Table 7.9 indicates the distribution of the responses regarding norms and publicity. Norms and publicity refer to the perceptions consumers have regarding laws, regulations, and related propaganda about e-waste recycling. From the low mean values (1.87 to 2.26) received on questions 11 to 14 (NP1 to NP4), the South African respondents indicated that there are no laws regulating e-waste recycling and not enough or relevant information is published in the media. This implication is that South African citizens do not participate in e-waste re-cycling as they do not know what to do with e-waste. This assumption is supported by the results from question 14, which indicated that the people who completed the survey mostly do not participate in e-waste recycling as indicated by the mean value of 2.25.

The standard deviations for question 11 (SD=1.03) and question 14 (SD=1.03) are relatively high. This suggests that the respondents opinion differ more in terms of these two issues regarding norms and publicity.

Table 7.9: Descriptive statistics of norms and publicity

NORMS AND PUBLICITY (NP)					
Item statements					
No	Indicator	Question	n	M	SD
11	NP1	There are sufficient laws and regulations governing e-waste recycling in South Africa.	517	2.26	1.04
12	NP2	The media publish enough information on formal e-waste recycling.	516	1.87	0.88
13	NP3	The media publish relevant information on formal e-waste recycling.	515	2.00	0.91
14	NP4	The people around me participate in formal e-waste recycling.	514	2.25	1.03
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
NP1	28.6	29.0	34.4	3.9	4.1
NP2	39.5	39.8	16.1	3.7	1.0
NP3	34.0	38.8	21.6	4.9	0.8
NP4	26.8	35.8	26.1	8.4	2.9

Table 7.10 indicates the distribution of the responses regarding the costs of recycling. The cost of recycling refers to the perceptions regarding travelling, disposal time, compensation, and handling charges. The mean values for this factor were between 2.92 and 3.38 for questions 15 to 18 (CoR1 to CoR4). The mean values around 3 can be attributed to the high percentages (Between 38% and 56.8%) of respondents who chose option 3 (neutral) for these items. This indicates a high degree of uncertainty around travelling costs, disposal time, compensation, and handling charges to dispose e-waste. The previous assumption that South African citizens do not participate in e-waste recycling is thus further supported by the feedback received from respondents.

Table 7.10: Descriptive statistics of costs of recycling

COSTS OF RECYCLING (CoR)					
Item statements					
No	Indicator	Question	n	M	SD
15	CoR1	Traveling costs to dispose e-waste is high.	516	3.38	0.94
16	CoR2	The time spent by me to dispose e-waste is high.	516	2.92	1.10
17	CoR3	The compensation for returning e-waste is too small to be worthwhile.	516	3.16	1.11
18	CoR4	The handling charges for e-waste recycling will be high.	516	3.20	0.87
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
CoR1	3.7	8.7	46.3	28.3	13.0
CoR2	11.6	21.7	38.0	20.7	7.9
CoR3	9.5	12.6	43.6	20.5	13.8
CoR4	3.7	10.3	56.8	20.7	8.5

Table 7.11 indicates the distribution regarding the convenience of recycling. The convenience of recycling refers to the perceptions respondents have regarding personal availability of time, transport, and the availability and proximity of recycling channels. In this construct, the mean values differed significantly, from 1.81 to 4.28. For question 19, 28.3% (10.7% + 17.6%) indicated they do not have time to dispose e-waste. The low mean value of 2.34 is an indication that the surveyed consumers in urban areas in general do not have the means to dispose of large e-waste items but will be able to dispose of small items correctly (mean = 4.28). The low mean values of 1.81 and 2.07 indicate that consumers agree that disposal channels are inadequate and not close to their neighbourhoods.

The standard deviations for question 20 is higher (SD=1.42) than for the other questions. This suggests that the respondents differ more in terms of the access to transport to take large e-waste to a collection point. This is most likely due to the type of vehicle they drive.

Table 7.11: Descriptive statistics of convenience of recycling

CONVENIENCE OF RECYCLING (ConR)					
Item statements					
No	Indicator	Question	n	M	SD
19	ConR1	I have time to deliver e-waste to a collection point.	516	3.30	1.25
20	ConR2	I have transport to take large e-waste (fridge, stove, etc.) to a collection point.	517	2.34	1.42
21	ConR3	I can take small e-waste (kettle, toaster, radio, etc.) to a collection point.	518	4.28	0.88
22	ConR4	I think recycling channels in my neighbourhood are adequate.	515	1.81	1.02
23	ConR5	I think recycling channels in my neighbourhood are close enough to my residence.	517	2.07	1.18
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
ConR1	10.7	17.6	20.7	32.9	18.0
ConR2	39.8	23.6	10.6	14.3	11.6
ConR3	1.9	3.3	6.8	40.5	47.5
ConR4	50.5	28.5	13.6	4.7	2.7
ConR5	43.3	25.5	16.4	10.6	4.1

Table 7.12 indicates the distribution of behavioural intention regarding e-waste recycling. The behaviour intention refers to consumers' willingness and behaviour towards recycling e-waste to formal recycling organisations and structures. The high mean values (4.07 to 4.34) for questions 24 to 26 (BI1 to BI3) indicated that respondents were willing to participate in disposal of e-waste, tell others how to dispose e-waste, and get information about correct disposal methods of e-waste, which would in turn reduce pollution.

The standard deviations for the questions 24 to 26 (BI1 to BI3) are relatively the same. This mean that the respondents do not really differ in term of agreement on these items.

Table 7.12: Descriptive statistics of behavioural intention regarding e-waste recycling

BEHAVIOURAL INTENTION (BI)					
Item statements					
No	Indicator	Question	n	M	SD
24	BI1	I am willing to spend time to take my old electronic appliances to collection points.	518	4.07	0.95
25	BI2	I am willing to speak to my friends about appropriate methods for disposal of e-waste.	515	4.16	0.87
26	BI3	I am willing to get more information about appropriate methods to dispose e-waste.	516	4.34	0.74
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
BI1	2.3	5.2	12.5	42.9	37.1
BI2	1.6	2.5	14.2	42.1	39.6
BI3	0.4	1.4	10.1	40.7	47.5

Table 7.13 shows the distribution of awareness and attitude towards a point's rewards system. Mean values and standard deviations were not calculated for these questions since dichotomous scale with "Yes" or "No" was used. The awareness and attitude towards a point reward system were tested to determine if consumers were aware of rewards points and to what degree they participate in existing systems. The majority of consumers (74.2%) were not aware of any point rewards system and an even higher percentage (79.6%) do not participate in it.

Table 7.13: Descriptive statistics of awareness and attitude towards a point's rewards system

AWARENESS AND ATTITUDE TOWARDS A POINTS REWARDS SYSTEM (AAT-PRS)			
Item statements			
No	Indicator	Question	n
27	<u>AAT-PRS1</u>	Are you aware of current Points Rewards Systems?	516
28	<u>AAT-PRS2</u>	Are you currently participating in any form of Points Rewards Systems?	514
n = The number of respondents			
Percentage of respondents selecting options			
Indicator		Yes	No
<u>AAT-PRS1</u>		25.8	74.2
<u>AAT-PRS2</u>		20.4	79.6

Table 7.14 summarizes the distribution of the responses regarding willingness to participate in e-waste recycling with point's rewards system. The high mean values (3.9 to 4.41) received on questions 29 to 32 (WP-PRS1 to WP-PRS4) indicated that respondents were willing to participate in a PRS system and that a point reward system would be important to them.

Table 7.14: Descriptive statistics of willingness to participate in e-waste recycling with point's rewards system

WILLINGNESS TO PARTICIPATE IN E-WASTE RECYCLING WITH POINTS REWARDS SYSTEM (WP-PRS)					
Item statements					
No	Indicator	Question	n	M	SD
29	WP-PRS1	I would be willing to participate in an organised e-waste recycling system, which uses a PRS.	517	4.41	0.79
30	WP-PRS2	An organised e-waste recycling system, which uses a PRS would make me aware of my own carbon footprint.	517	4.30	0.86
31	WP-PRS3	The number of points awarded when I return e-waste would be important to me.	516	3.90	1.06
32	WP-PRS4	The type of products/services awarded when I return e-waste would be important to me.	516	3.85	1.06
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
WP-PRS1	0.4	2.3	9.7	31.1	56.5
WP-PRS2	1.2	2.5	11.6	34.4	50.3
WP-PRS3	3.1	5.8	25.8	28.9	36.4
WP-PRS4	3.5	6.8	23.1	34.1	32.6

Table 7.15 shows the distribution of the responses regarding accountability to recycle e-waste. This construct measured the perceptions of consumers regarding who should be accountable for recycling e-waste, as well as the willingness of participants to pay a recycling fee. The original intention was to test this willingness of participants to pay a recycling fee as a separate construct, but the constructs were combined as a single construct in the SPSS analysis. The willingness to pay, which featured as a separate construct, will be discussed in the following sections.

The high mean values (3.84 to 4.19) received on questions 33.1 to 33.5 (AR1 to AR5) indicated respondents agreed regarding the government structures, producers, retailers, and the consumers need to take accountability to recycle e-waste. Respondents thus indicated that everyone involved with WEEE should take responsibility for the recycling of e-waste. Mean values (3.02 to 3.28) were calculated for questions 34 to 36 (AR6 to AR8).

Table 7.15: Descriptive statistics of accountability to recycle e-waste

ACCOUNTABILITY TO RECYCLE E-WASTE (AR)					
Item statements					
No	Indicator	Question	n	M	SD
33.1	AR1	I believe that the government should be responsible to recycle e-waste.	517	3.86	1.22
33.2	AR2	I believe that the manufacturer/importer of the electrical or electronic product should be responsible to recycle e-waste.	518	4.10	1.04
33.3.	AR3	I believe that the seller/retailer of the electrical or electronic product should be responsible to recycle e-waste.	515	3.84	1.11
33.4	AR4	I believe that the consumer of the electrical or electronic product should be responsible to recycle e-waste.	513	4.19	0.87
33.5	AR5	I believe that the municipalities should be responsible to recycle e-waste.	512	4.05	1.06
WILLINGNESS TOWARDS THE PAYMENT OF A RECYCLING FEE					
34	AR6	I believe that the payment of a recycling fee should be part of the product price when the product is purchased.	518	3.28	1.32
35	AR7	I believe that the payment of a recycling fee should be collected when the product is disposed.	514	3.17	1.34

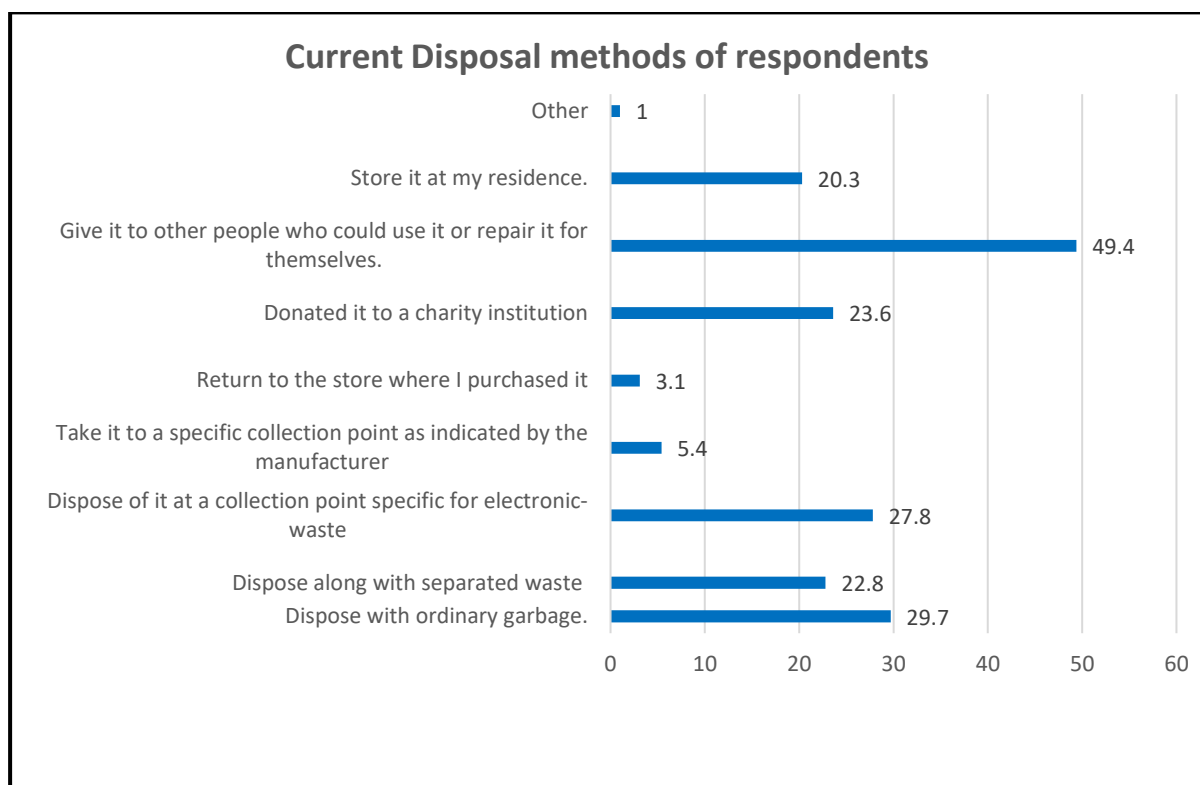
36	AR8	I am willing to pay for a part of the costs to recycle my e-waste.	514	3.02	1.25
37	AR9	If consumers <u>have</u> to pay part of the recycling costs for e-waste, what percentage of the selling price will be acceptable to you? a) 0-6%, b) 7-12%, c) 13-18%, d) 19-	518		
n = The number of respondents, M = Mean value, SD= Standard Deviation					
Percentage of respondents selecting options					
Indicator	Strongly disagree	Disagree	Neutral	Agree	Strongly
AR1	5.0	11.2	18.8	22.4	42.6
AR2	3.3	5.0	14.7	32.2	44.8
AR3	4.5	7.4	22.3	31.7	34.2
AR4	1.4	3.1	12.7	40.4	42.5
AR5	3.3	6.3	15.2	32.8	42.4
AR6	13.1	14.5	27.2	21.8	23.4
AR7	15.8	15.4	25.1	23.3	20.4
AR8	15.2	18.5	28.4	24.7	13.2
Percentage of respondents selecting options					
Indicator	0-6%	7-12%	13- 18%	19-24%	>25%
AR9	80.1%	13.9%	2.5%	2.3%	1.2%

Just more than one third of the sample (37.9%) indicated a willingness to pay a recycling fee (question 36-AR8), while the rest were neutral or disagreed with the payment of a recycling fee. This attitude is also reflected in the questions that requested preferences of whether recycling fees must be included when the product was purchased or paid if disposed. The majority responded by selecting options strongly disagree, disagree or neutral on the five point Likert scale. The attitude can further be observed, as more than 80% opted to pay only 0 to 6% and almost 14% opted to pay 7 to 12% of the selling price towards a recycling fee (question 37-AR9). As it does not make sense to determine means and standard deviations for categorical variables, only the frequencies are indicated for question 37.

The researcher wanted to get a sense of the current disposal behaviour of consumers in the South African market regarding e-waste. It can be seen in Figure 7.7 that the percentages do not add up to 100%. The total percentages are in fact higher, because consumers could select more than one option of disposal.

A mere 33.2% disposed of e-waste correctly at formal e-waste disposal points (“Dispose of it at an e-waste collection point” 27.8%, and “Take it to a collection point-indicated by the manufacturer” 5.4%). The majority however disposed of e-waste with their ordinary garbage, donated items, gave to other people or disposed with separated waste. The latter methods were ways of handing over the problem to someone else who must dispose of the end-of-life items in the near future.

Figure 7.7: Question 38-Current South African e-waste disposal methods



7.5 FACTOR ANALYSIS AND COMPOSITE RELIABILITY

Tabachnick and Fidell (2007:613) suggest that least 300 cases/respondents is needed to conduct a factor analysis. The response from more than 500 respondents for the survey was thus sufficient for factor analysis. Statistical Package for the Social Sciences (SPSS) version 25 was used to analyse the data. The PCA method, with Oblimin rotation, was used for the factor analysis. This technique attempts to produce a smaller number of linear combinations of the original variables in a way that captured (or accounts for) most of the variability in the pattern of correlations (Pallant, 2011:182).

SPSS software generated two statistical measures to help assess the factorability of the data for factor analysis. The first is the Bartlett's test of sphericity (Bartlett, 1954). For this test to be significant, the p value must be smaller than 0.05. The second measure is the KMO measure of sampling adequacy (Kaiser 1970, 1974). The KMO index ranges from 0 to 1 and for this test to be significant, it is suggested that the KMO value should be at least 0.6 for a good factor analysis (Tabachnick & Fidell, 2007). However a minimum of 0.5 is also acceptable (Kaiser, 1974).

In the table to follow, the results of the Bartlett's test of sphericity on the constructs were not indicated as all the p values were ≤ 0.001 . Only the KMO values were in the tables, as they would determine if factor analysis was appropriate. Kaiser's criterion, or the Eigenvalue rule, is one of the most commonly used techniques to retain factors for further investigation. Only factors with an Eigenvalue of 1.0 or more were used. The Eigenvalue of a factor represents the amount of the total variance explained by that factor (Pallant, 2011:184).

Another aspect of reliability to be assessed is internal consistency. Internal consistency is the degree to which the items that make up the scale are all measuring the same fundamental attribute. The most common method to measure internal consistency is the Cronbach's alpha coefficient, which is available in SPSS. This statistic measure gives an indication of the average correlation among all the items that make up the scale. The Cronbach alpha values are from 0 to 1, where values closer to 1 indicate greater reliability (Pallant, 2011:6).

Depending on the nature and the purpose of the scale, different levels of reliability are required, but a minimum Cronbach alpha level of 0.7 is recommended (Nunnally, 1978; DeVellis, 2003). When there are less than ten constructs, in this study there are ten, it is common for Cronbach Alpha values to go as low as 0.5, and still be acceptable (Pallant, 2011:97). Cronbach alpha values of below 0.7 can be expected and allowed because there are a variety of the constructs being tested when researchers deal with psychological constructs (Field, 2009:675). In the e-waste consumer study conducted by Echegaray and Hansstein (2017:188) the Cronbach Alpha of Behaviour Intention was 0.61. The same questions were used in this study, with slight changes, and a Cronbach alpha of 0.8 was obtained in the South African study. In this research two constructs having Cronbach Alpha's of close to 0.6 were thus included in the development of the measuring instrument as it is deemed acceptable by various authors and used in similar e-waste studies.

Table 7.16: Composite reliability and convergent validity of constructs

Factor	KMO	New Heading	% Variance	Indicator # Old Indicator	Factor Loadings	Cronbach alpha	M	SD
Environmental awareness (EA)	0.70		73.35	EA2	0.88	0.80	4.61	0.56
				EA3	0.88			
				EA1	0.81			
Attitude towards e-waste recycling (ATR)	0.84		54.39	ATR6	0.84	0.81	4.51	0.52
				ATR7	0.82			
				ATR5	0.79			
				ATR4	0.77			
				ATR3	0.76			
				ATR1	0.72			
				ATR2	0.34			
Norms and publicity (NP)	0.68		56.16	NP3	0.87	0.71	2.10	0.71
				NP2	0.87			
				NP1	0.68			
				NP4	0.52			
Cost of recycling (CoR)	0.71		55.02	CoR1	0.78	0.72	3.17	0.75
				CoR4	0.75			
				CoR2	0.74			
				CoR3	0.70			
Convenience of recycling	0.53	Personal convenience of e-waste recycling (PC)	67.66	PC1/ ConR1 [#]	0.84	0.60	3.31	0.9
				PC2/ ConR3 [#]	0.72			
				PC3/ ConR2 [#]	0.69			
		Convenience of facilities (CoF)		CoF1/ ConR4 [#]	0.91	0.78	1.94	1.0
				Cof2/ ConR5 [#]	0.90			
Behavioural Intention (BI)	0.70		72.17	BI2	0.88	0.80	4.19	0.73
				BI1	0.84			
				BI3	0.83			
Awareness and Attitude towards PRS (AAT-PRS)	0.50		77.31	AAT-PRS2	0.88	0.71	0.77	0.37
				AAT-PRS1	0.88			
Willingness to participate in e-waste recycling with a point rewards system (WP-PRS)	0.67		66.03	WP-PRS3	0.87	0.83	4.12	0.77
				WP-PRS4	0.84			
				WP-PRS2	0.78			
				WP-PRS1	0.76			
Accountability to recycle e-waste (AR)	0.64	Accountability-Producer to Consumer (Acc-PtC)	59.03	Acc-PtC1/AR2	0.89	0.67	4.04	0.79
				Acc-PtC2/AR3	0.89			
				Acc-PtC3/AR4	0.43			
		Willingness towards the payment of a recycling fee (WTPRF)		WTPRF1/AR6	0.62	0.60	2.69	0.81
				WTPRF2/AR7	0.69			
				WTPRF3/AR8	0.77			
				WTPRF4/AR9	0.57			
				AR9				
		Accountability-Government structures (Acc-GS)		Acc-GS1/AR1	0.90	0.73	3.95	1.02
				Acc-GS2/AR5	0.82			

- ***Environmental awareness***

The three items of the environmental awareness construct were subjected to PCA using SPSS. The suitability of data for factor analysis was firstly assessed prior to performing PCA. The KMO value was 0.7 (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis is appropriate.

The PCA revealed the presence of only one component with an Eigenvalue of 2.2 (thus >1), explaining 73.35% of the variance. The factor loadings of the different items are shown and range from 0.81 to 0.88. In the current study, the Cronbach alpha coefficient was 0.8 for environmental awareness, which indicates the items making up the scale were all measuring the same fundamental attribute.

- ***Attitude towards e-waste recycling***

The seven items of the attitude towards e-waste recycling construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.84, (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis is appropriate.

The PCA revealed the presence of only one component with an Eigenvalue of 3.8 (thus >1), explaining 54.39% of the variance. The factor loadings of the different items are shown and range from 0.34 to 0.84. The Cronbach alpha coefficient was 0.81 for Attitude towards e-waste recycling, which indicates the items that make up the scale all measured the same fundamental attribute.

- ***Norms and publicity***

The four items of the norms and publicity construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.68 (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis was appropriate. PCA revealed the presence of only one component with an Eigenvalue of 2.25 (thus >1), explaining 56.16% of the variance. The factor loadings of the different items are shown and ranged from 0.52 to 0.87. The Cronbach alpha coefficient was 0.71 for norms and publicity, which indicated the items that make up the scale all measured the same fundamental attribute.

- ***Cost of Recycling***

The four items of the cost of recycling construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.71, (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating factor analysis was appropriate. PCA revealed the presence of only one component with an Eigenvalue of 2.2 (thus >1), explaining 55.02% of the variance. The factor loadings of the different items ranged from 0.70 to 0.78. The Cronbach alpha coefficient was 0.72 for cost of recycling, which indicated the items that make up the scale were all measuring the same fundamental attribute.

- ***Convenience of recycling***

The original construct was named convenience of recycling and consisted of five items that were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.53, thus lower than the recommended value of 0.6 (Tabachnick & Fidell, 2007), but still above the bare minimum of 0.5 (Kaiser, 1974).

The Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis was still appropriate. PCA revealed the presence of two components with Eigenvalues exceeding 1 (1.75 and 1.64 respectively), explaining 67.66% of the variance, with Component 1 contributing 34.95% and Component 2 contributing 32.72% of the variance respectively. An inspection of the Scree plot also revealed a clear break after the second component.

For the interpretation of these two components, the Oblimin with the Kaiser Normalisation rotation method was performed. Component 1 was named personal convenience of e-waste recycling (PC) while Component 2 named convenience of facilities. The factor loadings of personal convenience ranged from 0.69 to 0.84, while those for convenience of facilities were 0.90 and 0.91. In the current study, the Cronbach alpha coefficient was 0.6 for personal convenience of e-waste recycling and 0.78 for convenience of facilities, which indicated the items that make up the scale were all measuring the same fundamental attributes.

- ***Behavioural intention***

The three items of the behavioural intention construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.70, (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance $p \leq 0.000$, indicating that factor analysis was appropriate. PCA revealed the presence of only one component with an Eigenvalue of 2.17 (thus >1), explaining 72.17% of the variance. The factor loadings of the different items are shown and ranged from 0.83 to 0.88. In the current study, the Cronbach alpha coefficient was 0.80 for behavioural intention, which indicated the items making up the scale were all measuring the same fundamental attribute.

- ***Awareness and attitude towards point reward system***

The two items of the awareness and attitude towards point reward system construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.50, thus lower than the recommended value of 0.6 (Tabachnick & Fidell, 2007), but still equal to the bare minimum of 0.5 (Kaiser, 1974).

The Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating factor analysis was still appropriate. PCA revealed the presence of one component with an Eigenvalue of 1.55 (thus >1), explaining 77.31% of the variance. The factor loadings of the different items are shown, and both were equal to 0.88. Although the KMO was 0.50, the Cronbach alpha coefficient was 0.71 for Awareness and Attitude towards PRS, which indicated the items making up the scale were all measuring the same fundamental attribute.

- ***Willingness to participate in e-waste recycling with a point rewards system***

The four items of the willingness to participate in e-waste recycling with point rewards system construct were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.67, (thus >0.6) and Bartlett's Test of Sphericity reached statistical significance ($p \leq 0.001$), indicating that factor analysis was appropriate (Tabachnick & Fidell, 2007).

The PCA revealed the presence of only one component with an Eigenvalue of 2.64 (thus >1), explaining 66.03% of the variance. The factor loadings of the different items are shown and ranged from 0.76 to 0.87. In the current study, the Cronbach alpha coefficient was 0.83 for willingness to participate in e-waste recycling with point rewards system, which indicated the items making up the scale were all measuring the same fundamental attribute.

- ***Accountability to recycle e-waste factor***

The original construct was named accountability to recycle e-waste and consisted of nine items, which were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.64, thus higher than the recommended value of 0.6. The Bartlett's Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis was appropriate. PCA revealed the presence of three components with Eigenvalues exceeding 1 (2.49, 1.69, and 1.14 respectively), explaining 59.03% of the variance, with Component 1 contributing 27.66%, Component 2 contributing 18.74%, and Component 3 contributing 12.63% of the variance respectively. For the interpretation of these three components, the Oblimin with the Kaiser Normalisation rotation method was performed. Component 1 was named accountability-producer to consumer, component 2 was named willingness towards the payment of a recycling fee, and component 3 was named accountability-Government structures.

As mentioned, component 2 was an original construct but was incorporated with the accountability to recycle e-waste during the SPSS analysis. The factor loadings of Producer to Consumer ranged from 0.43 to 0.89, those of willingness towards the payment of a recycling fee ranged from 0.57 to 0.77, and those for Government Structures were 0.82 and 0.90. In the current study, the Cronbach alpha coefficient was 0.67 for Producer to Consumer, 0.60 for willingness towards the payment of a recycling fee, and 0.73 for Government Structures, which indicate that the items that make up the scale are all measuring the same fundamental attributes.

- ***Current disposal habits***

The original construct was named “Current disposal habits” and consisted of eight items, which were subjected to PCA using SPSS. The suitability of data for factor analysis was assessed prior to performing PCA. The KMO value was 0.52 thus lower than the recommended value of 0.6 (Tabachnick & Fidell, 2007), but still above the bare minimum of 0.5 (Kaiser, 1974). The Bartlett’s Test of Sphericity reached statistical significance $p \leq 0.001$, indicating that factor analysis was appropriate. PCA revealed the presence of three components with Eigenvalues exceeding 1 (1.72, 1.27, and 1.04 respectively), explaining 50.74% of the variance, with Component 1 contributing 21.50%, Component 2 contributing 15.83%, and Component 3 contributing 13.41% of the variance respectively. For the interpretation of these three components, the Oblimin with the Kaiser Normalization rotation method was performed.

The factor loadings of the different components are indicated in Table 7.16 above. In the current study, the Cronbach alpha coefficient for Current disposal habits ranged from - 0.39 to 0.43, which was too low to be considered as single factors. Reporting on further tests will be done on each item individually. The Cronbach alpha coefficient for the rest of the factors were 0.6 or above, making all the factors statistically valid and reliable.

7.6 THE EFFECT OF BIOGRAPHICAL VARIABLES ON THE FACTORS

Three different types of test were conducted to measure the effects of biographical variables on factors. They are the T-tests, the ANOVA tests, and the Spearman’s rank order correlation.

An independent-samples T-test is used for categorical data to compare the mean score, on some continuous variable, for two different groups of participants, e.g. comparing the factors against male and female data (Pallant, 2011:239).

An ANOVA test is used for categorical data when comparing the mean scores of more than two groups. This test contrast the variance (variability in scores) amongst different groups (represented by an independent variable) with the variability within each of the groups (believed to be due to chance)” (Pallant, 2011:249).

The Spearman's rank order correlation is used for ordinal data to determine the strength of the relationship between two continuous variables. Ordinal data refers to data that has been ranked (Pallant, 2011:103). The relationship between the demographical data and ordinal data will be analysed using this test.

7.7 THE T-TEST

An independent-samples t-test is used to compare the mean score, on some continuous variable, for two different groups of participants, i.e. whether males and females differ significantly in terms of the different factors generated from the questionnaire. In statistical terms, one is testing the probability that the two sets of scores (for males and females) came from the same population. If the Sigma (2-tailed) value or p value is >0.05 , the conclusion is there is *not* a statistically significant difference in the mean scores of the factor for males and females, and if the p value is <0.05 then the conclusion is that there is a statistically significant difference in the mean scores of the factor for males and females (Pallant, 2011:239-240).

Effect size statistics provide an indication of the importance of the magnitude of differences between the groups in practice (not just whether the difference could have occurred by chance). One of the most commonly used effect size statistics is the eta squared, which ranges from 0 to 1 and represents the proportion of variance in the dependent variable that is explained by the independent (group) variable. The guidelines for interpreting this value where $\eta^2=0.01$ is a small effect, $\eta^2=0.06$ is a moderate effect, and $\eta^2= 0.14$ is large effect (Cohen, 1988:284).

Another way to comment on practical significance is a measure called the Cohen's d effect size (d), which not only makes the difference independent of units and sample size but relates it with the spread of the data (Ellis & Steyn, 2003:51-53). The effect size is

calculated as $d = \frac{|\bar{X}_1 - \bar{X}_2|}{S_{\max}}$ where the population SD's σ_1 and σ_2 are not necessarily

equal and $S_{\max} = \text{maximum of } S_1 \text{ and } S_2$, the sample SD's. The guidelines for interpreting this value are $d=0.2$ (small effect), $d=0.5$ (medium effect), and $d=0.8$ (large effect) (Cohen, 1988: 284-287). Data where $d \geq 0.8$ is practically significant as it is the result of a difference having a large effect (Ellis & Steyn, 2003:51).

7.8 THE T-TEST FOR GENDER COMPARISON

- **Gender comparison regarding environmental awareness**

An independent-samples t-test was conducted to compare the environmental awareness scores for males and females. It can be seen in Table 7.17 that there is a statistically significant difference ($p < 0.05$) in scores with males ($M = 4.56$, $SD = 0.6$) having lower environmental awareness than females ($M = 4.67$, $SD = 0.5$; $t(508.41) = -2.21$, $p = 0.027$, two-tailed). The magnitude of the differences in the means (mean difference = -0.11 , 95% CI : -0.20 to -0.01) was small for the Eta squared ($\eta^2 = 0.01$) and the effect size ($d = 0.18$).

Table 7.17: Environmental Awareness (EA)

Factor	Gender		n	M	SD			
EA	Male		274	4.56	0.60			
	Female		237	4.67	0.50			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-2.21	508.41	0.027	-0.11	-0.20	-0.01	0.010	0.18

- **Gender comparison regarding attitude towards e-waste recycling**

An independent-samples t-test was conducted to compare the “Attitude towards e-waste recycling” scores for males and females. It can be seen in Table 7.18 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=4.48$, $SD=0.54$) and females ($M=4.54$, $SD=0.49$; $t(514) = -1.46$, $p=0.146$, two-tailed).

Table 7.18: Attitude towards e-waste recycling (ATR)

Factor	Gender		n	M	SD			
ATR	Male		276	4.48	0.54			
	Female		240	4.54	0.49			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-1.46	514	0.146	-0.07	-0.16	0.02	0.004	0.12

- **Gender comparison regarding norms and publicity**

An independent-samples t-test was conducted to compare the norms and publicity scores for males and females. It can be seen in Table 7.19 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=2.12$, $SD=0.7$) and females ($M=2.08$, $SD=0.72$; $t(514)=0.63$, $p=0.527$, two-tailed).

Table 7.19: Norms and Publicity (NP)

Factor	Gender		n	M	SD			
NP	Male		276	2.12	0.70			
	Female		240	2.08	0.72			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	0.63	514	0.527	0.04	-0.08	0.16	0.001	0.05

- **Gender comparison regarding cost of recycling**

An independent-samples t-test was conducted to compare the cost of recycling scores for males and females. It can be seen in Table 7.20 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 3.23$, $SD = 0.75$) and females ($M = 3.11$, $SD = 0.75$; $t(513) = 1.85$, $p = 0.065$, two-tailed).

Table 7.20: Cost of recycling (CoR)

Factor	Gender		n	M	SD			
CoR	Male		275	3.23	0.75			
	Female		240	3.11	0.75			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	1.85	513	0.065	0.12	-0.01	0.25	0.007	0.16

- **Gender comparison regarding personal convenience of e-waste recycling**

An independent-samples t-test was conducted to compare the personal convenience of e-waste recycling scores for males and females. There was a statistically significant difference ($p < 0.05$) in scores for males ($M = 3.47$, $SD = 0.86$) and females ($M = 3.14$, $SD = 0.92$; $t(513) = 4.16$, $p = 0.000$, two-tailed). The magnitude of the differences in the means (mean difference = 0.33, 95% CI: 0.17 to 0.48) was a moderate effect for the Eta squared ($\text{Eta}^2 = 0.033$) and the effect size ($d = 0.36$) was medium.

Table 7.21: Personal Convenience of e-waste recycling (PC)

Factor	Gender		n	M	SD			
PC	Male		275	3.47	0.86			
	Female		240	3.14	0.92			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	4.16	513	0.000	0.33	0.17	0.48	0.033	0.36

- **Gender comparison regarding personal convenience of facilities**

An independent-samples t-test was conducted to compare the convenience of facilities scores for males and females. It can be seen in Table 7.22 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 1.92$, $SD = 0.94$) and females ($M = 1.97$, $SD = 1.08$; $t(475.35) = -0.5$, $p = 0.618$, two-tailed).

Table 7.22: Convenience of Facilities (CoF)

Factor	Gender		n	M	SD			
CoF	Male		275	1.92	0.94			
	Female		239	1.97	1.08			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	-0.50	475.35	0.618	-0.04	-0.22	0.13	0.000	0.04

- **Gender comparison regarding behavioural intention**

An independent-sample t-test was conducted to compare the behavioural intention scores for males and females. It can be seen in Table 7.23 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 4.16$, $SD = 0.74$) and females ($M = 4.22$, $SD = 0.72$; $t(514) = -0.91$, $p = 0.362$, two-tailed).

Table 7.23: Behavioural intention (BI)

Factor	Gender		n	M	SD			
BI	Male		275	4.16	0.74			
	Female		239	4.22	0.72			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	-0.91	512.00	0.362	-0.06	-0.19	0.07	0.002	0.08

- **Gender comparison regarding awareness and attitude towards a point rewards system**

An independent-samples t-test was conducted to compare the awareness and attitude towards a point rewards system scores for males and females. It can be seen in Table 7.24 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 0.76$, $SD = 0.38$) and females ($M = 0.78$, $SD = 0.37$; $t(514) = -0.59$, $p = 0.554$, two-tailed).

Table 7.24: Awareness and Attitude towards a point rewards system (AAT-PRS)

Factor	Gender		n	M	SD			
AAT-PRS	Male		275	0.76	0.38			
	Female		241	0.78	0.37			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-0.59	514	0.554	-0.02	-0.08	0.05	0.001	0.05

- **Gender comparison regarding willingness to participate in e-waste recycling with a point rewards system**

An independent-samples t-test was conducted to compare the willingness to participate in e-waste recycling with a point rewards system” scores for males and females. It can be seen in Table 7.25 that there was no statistically significant difference ($p>0.05$) in scores for males ($M = 4.07$, $SD = 0.77$) and females ($M=4.17$, $SD=0.77$; $t(513) = -1.44$, $p=0.151$, two-tailed).

Table 7.25: Willingness to participate in e-waste recycling with a point rewards system (WP-PRS)

Factor	Gender		n	M	SD			
WP-PRS	Male		275	4.07	0.77			
	Female		240	4.17	0.77			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
					-0.23	0.04	0.004	0.13

- **Gender comparison regarding accountability-government structures**

An independent-samples t-test was conducted to compare the accountability-Government structures scores for males and females. It can be seen in Table 7.26 that there was a statistically significant difference ($p < 0.05$) in scores for males ($M = 3.87$, $SD = 1.10$) and females ($M = 4.05$, $SD = 0.91$; $t(511.01) = -2.04$, $p = 0.042$, two-tailed). The magnitude of the differences in the means (mean difference = -0.18 , 95% CI: -0.36 to 0.01) was small for the Eta squared ($\eta^2 = 0.008$) and the effect size ($d = 0.17$) was small.

Table 7.26: Accountability-Government structures (Acc-GS)

Factor	Gender		n	M	SD			
Acc-GS	Male		275	3.87	1.10			
	Female		239	4.05	0.91			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-2.04	511.01	0.042	-0.18	-0.36	-0.01	0.008	0.17

- **Gender comparison regarding accountability-producer to consumer**

An independent-samples t-test was conducted to compare the accountability-producer to consumer scores for males and females. It can be seen in Table 7.27 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 4.00$, $SD = 0.81$) and females ($M = 4.09$, $SD = 0.77$; $t(512) = -1.21$, $p = 0.226$, two-tailed).

Table 7.27: Accountability-Producer to Consumer (Acc-PtC)

Factor	Gender		n	M	SD			
Acc-PtC	Male		274	4.00	0.81			
	Female		240	4.09	0.77			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-1.21	512	0.226	-0.08	-0.22	0.05	0.003	0.10

- **Gender comparison regarding willingness towards the payment of recycling fee**

An independent-samples t-test was conducted to compare the willingness towards the payment of a recycling fee scores for males and females. It can be seen in Table 7.28 that there was a statistically significant difference ($p < 0.05$) in scores for males ($M = 2.61$, $SD = 0.8$) and females ($M = 2.78$, $SD = 0.81$; $t(515) = -2.29$, $p = 0.022$, two-tailed). The magnitude of the differences in the means (mean difference = -0.16 , 95% CI: -0.30 to 0.02) was a moderate effect for the Eta squared ($\eta^2 = 0.01$) and the effect size ($d = 0.201$) was small.

Table 7.28: Willingness towards the payment of a recycling fee (WTPRF)

Factor	Gender		n	M	SD			
WTPRF	Male		275	2.61	0.80			
	Female		242	2.78	0.81			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-2.29	515	0.022	-0.16	-0.30	-0.02	0.01	0.201

- **Gender comparison regarding disposal of e-waste with ordinary garbage**

An independent-samples t-test was conducted to compare the dispose with ordinary garbage scores for males and females. It can be seen in Table 7.29 that there was no statistically significant difference ($p > 0.05$) in scores for males ($M = 0.33$, $SD = 0.47$) and females ($M = 0.26$, $SD = 0.44$; $t(513.61) = 1.63$, $p = 0.105$, two-tailed).

Table 7.29: Dispose with ordinary garbage (D1)

Factor	Gender		n	M	SD			
D1	Male		276	0.33	0.47			
	Female		242	0.26	0.44			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	1.63	513.61	0.105	0.07	-0.01	0.14	0.005	0.14

- **Gender comparison regarding disposal of e-waste along with separated waste**

An independent-samples t-test was conducted to compare the dispose along with separated waste scores for males and females. It can be seen in Table 7.30 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.26$, $SD=0.44$) and females ($M=0.19$, $SD=0.4$; $t(515.47)=1.72$, $p=0.086$, two-tailed).

Table 7.30: Dispose along with separated waste (D2)

Factor	Gender		n	M	SD			
D2	Male		276	0.26	0.44			
	Female		242	0.19	0.40			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	1.72	515.47	0.086	0.06	-0.01	0.14	0.006	0.14

- **Gender comparison regarding disposal of e-waste at a collection point specific for electronic-waste**

An independent-samples t-test was conducted to compare the dispose of it at a collection point specific for electronic-waste scores for males and females. It can be seen in Table 7.31 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.28$, $SD=0.45$) and females ($M=0.28$, $SD=0.45$; $t(516)=0.05$, $p=0.957$, two-tailed).

Table 7.31: Dispose of it at a collection point specific for electronic-waste (D3)

Factor	Gender		n	M	SD			
D3	Male		276	0.28	0.45			
	Female		242	0.28	0.45			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	0.05	516	0.957	0.00	-0.08	0.08	0.000	0.00

- **Gender comparison regarding taking of e-waste to a specific collection point as indicated by the manufacturer**

An independent-samples t-test was conducted to compare the take it to a specific collection point as indicated by the manufacturer scores for males and females. It can be seen in Table 7.32 that there was a statistically significant difference ($p < 0.05$) in scores for males ($M = 0.03$, $SD = 0.16$) and females ($M = 0.09$, $SD = 0.28$; $t(366.75) = -3.00$, $p = 0.003$, two-tailed). The magnitude of the differences in the means (mean difference = -0.06 , 95% CI : -0.10 to -0.02) was a moderate effect for the Eta squared ($\eta^2 = 0.017$) and the effect size ($d = 0.22$) was small.

Table 7.32: Take it to a specific collection point as indicated by the manufacturer (D4)

Factor	Gender		n	M	SD			
D4	Male		276	0.03	0.16			
	Female		242	0.09	0.28			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
					-0.10	-0.02	0.017	0.22

- **Gender comparison regarding returning of e-waste to the store where purchased**

An independent-samples t-test was conducted to compare the return to the store where I purchased it scores for males and females. It can be seen in Table 7.33 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.02$, $SD=0.13$) and females ($M=0.05$, $SD=0.21$; $t(400.03)=-1.75$, $p=0.081$, two-tailed).

Table 7.33: Return to the store where I purchased it (D5)

Factor	Gender		n	M	SD			
D5	Male		276	0.02	0.13			
	Female		242	0.05	0.21			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-1.75	400.03	0.081	-0.03	-0.06	0.00	0.006	0.13

- **Gender comparison regarding donating of e-waste to a charity institution**

An independent-samples t-test was conducted to compare the donated it to a charity institution scores for males and females. It can be seen in Table 7.34 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.21$, $SD=0.41$) and females ($M=0.27$, $SD=0.44$; $t(493.1)=-1.55$, $p=0.121$, two-tailed).

Table 7.34: Donated it to a charity institution (D6)

Factor	Gender		n	M	SD			
D6	Male		276	0.21	0.41			
	Female		242	0.27	0.44			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper		
	-1.55	493.10	0.121	-0.06	-0.13	0.02	0.005	0.13

- **Gender comparison regarding giving of e-waste to other people**

An independent-samples t-test was conducted to compare the give it to other people who could use it or repair it for themselves scores for males and females. It can be seen in Table 7.35 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.48$, $SD=0.5$) and females ($M=0.52$, $SD=0.5$; $t(516) = -0.96$, $p=0.337$, two-tailed).

Table 7.35: Give it to other people (D7)

Factor	Gender	n	M		SD			
D7	Male	276	0.48		0.50			
	Female	242	0.52		0.50			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	-0.96	516	0.337	-0.04	-0.13	0.04	0.002	0.08

- **Gender comparison regarding storing of e-waste at home**

An independent-samples t-test was conducted to compare the store it at my residence scores for males and females. It can be seen in Table 7.36 that there was no statistically significant difference ($p>0.05$) in scores for males ($M=0.19$, $SD=0.39$) and females ($M=0.22$, $SD=0.42$; $t(497.22) = -0.97$, $p=0.331$, two-tailed).

Table 7.36: Store it at my residence (D8)

Factor	Gender		n	M	SD			
D8	Male		276	0.19	0.39			
	Female		242	0.22	0.42			
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Eta ²	d
					Lower	Upper	Small	Small
	-0.97	497.22	0.331	-0.03	-0.10	0.04	0.002	0.08

- ***Conclusion regarding comparison between genders in terms of constructs***

The results reported above showed that there were a statistically significant differences in scores for males and females for environmental awareness, personal convenience of e-waste recycling, accountability-government structures, willingness towards the payment of a recycling fee, and taking of e-waste to a specific collection point as indicated by the manufacturer.

7.9 ANALYSIS OF VARIANCE (ANOVA) TESTS FOR COMPARING LANGUAGE GROUPS

The ANOVA test is used when comparing the mean scores of more than two groups. For this research, the groups consisted of respondents from different language groups in South Africa. ANOVA tests compare the variance (variability in scores) between the different language groups with the variability within each of the groups (believed to be due to chance). In this situation a One-way ANOVA is used which involves one grouping variable, which has numerous different levels. Post-hoc tests need to be conducted to indicate which of the groups differ (Pallant, 2011:249). The analysis starts with the ANOVA table, which is obtained from the SPSS software. The most important factor is the column marked Sig., as this is also the p value. If the p value is less than or equal to 0.05, then there is a significant difference somewhere among the mean scores on the dependent variable for the different language groups in this case. An F ratio represents the variance between the groups divided by the variance within the different groups.

If there is more variability between the groups (caused by the independent variable) than there is within each group (referred to as the error term) a large F ratio will be obtained (Pallant, 2011:253-254).

In the discussions to follow, regarding the post-hoc test table's for languages, only effect sizes from 0.35 and above will be discussed as lower effect sizes have small effects. The abbreviations are Lan=Language and for the different languages it will be Afr=Afrikaans, Eng=English, and Afri=African languages. The Means (M) value is also indicated in the table to enable interpretation.

Table 7.37: Analysis of variance (ANOVA) table for all variables and abbreviations

Factor	Abbreviation	F	Sig. or <i>P</i> value
Environmental awareness	EA	0.782	0.563
Attitude towards e-waste recycling	ATR	1.757	0.120
Norms and publicity	NP	1.563	0.169
Cost of recycling	CoR	1.817	0.108
Personal convenience of e-waste recycling	PC	1.115	0.351
Convenience of facilities	CoF	4.588	0.000
Behavioural intention	BI	1.202	0.307
Awareness and attitude towards PRS	AAT-PRS	2.572	0.026
Willingness to participate in e-waste recycling with a point rewards system	WP-PRS	2.348	0.040
Accountability- Government structures	Acc-GS	0.951	0.448
Accountability- producer to consumer	Acc-PtC	0.418	0.836
Willingness towards the payment of a recycling fee	WTPRF	0.396	0.852
Dispose with ordinary garbage	D1	2.441	0.034
Dispose along with separated waste	D2	1.558	0.171
Dispose of it at a collection point specific for electronic-waste	D3	2.264	0.047
Take it to a specific collection point as indicated by the manufacturer	D4	0.781	0.564
Return to the store where I purchased it	D5	1.786	0.114
Donated it to a charity institution	D6	2.025	0.074
Give it to other people who could use it or repair it for themselves	D7	1.039	0.394
Store it at my residence	D8	1.993	0.078

- **Language group comparison regarding environmental awareness and attitude towards e-waste recycling**

Table 7.38 indicates the effect sizes but as they are lower than 0.35 it will not be discussed.

Table 7.38: Post-hoc tests on languages and factors “Environmental Awareness” and “Attitude towards e-waste recycling”

EA					ATR				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
4.64	0.52	Afr			4.53	0.50	Afr		
4.61	0.55	Eng	0.06		4.50	0.51	Eng	0.06	
4.59	0.57	Afri	0.08	0.03	4.51	0.48	Afri	0.04	0.02
EA=Environmental awareness, ATR=Attitude towards e-waste recycling.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding norms and publicity and cost of recycling**

Table 7.39 indicates the effect sizes but as they are lower than 0.35 it will not be discussed.

Table 7.39: Post-hoc tests on languages and factors “Norms and publicity” and “Cost of Recycling”

NP					CoR				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
2.03	0.69	Afr			3.19	0.76	Afr		
2.09	0.67	Eng	0.10		3.12	0.75	Eng	0.09	
2.25	0.85	Afri	0.26	0.18	3.27	0.73	Afri	0.11	0.20
NP=Norms and publicity, CoR=Cost of recycling.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- ***Language group comparison regarding personal convenience of e-waste recycling and convenience of facilities***

Table 7.40 indicates that the effect size between Afrikaans speaking respondents and African language respondents leaned towards a medium effect ($d=0.39$). Afrikaans speaking respondents ($M=3.34$, $SD=0.91$) indicated they have more time and the means (PC) to dispose of small and large e-waste compared to respondents speaking African languages ($M=2.98$, $SD=0.92$).

The effect size between English speaking respondents and African language respondents also leaned towards a medium effect ($d=0.43$). English speaking respondents ($M=3.38$, $SD=0.85$) also indicated they have more time and the means (PC) to dispose of small and large e-waste compared to respondents speaking African languages ($M=2.98$, $SD=0.92$). Future research should investigate the findings to determine why African language speakers have less time and means to dispose e-waste compared to Afrikaans and English speaking respondents.

Table 7.40: Post-hoc tests on languages and factors “Personal Convenience of e-waste recycling” and “Convenience of Facilities”

PC					CoF				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
3.34	0.91	Afr			1.82	0.96	Afr		
3.38	0.85	Eng	0.03		2.04	0.99	Eng	0.23	
2.98	0.92	Afri	0.39	0.43	1.90	1.11	Afri	0.07	0.13
PC= Personal convenience of e-waste recycling, CoF=Convenience of facilities.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- ***Language group comparison regarding behavioural intention and awareness and attitude towards PRS***

Table 7.41 indicates the effect sizes but as they are lower than 0.35 it will not be discussed.

Table 7.41: Post-hoc tests on languages and factors “Behavioural Intention” and “Awareness and Attitude towards PRS”

BI					AAT-PRS				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
4.20	0.71	Afr			0.79	0.36	Afr		
4.17	0.70	Eng	0.05		0.75	0.38	Eng	0.11	
4.19	0.85	Afri	0.01	0.03	0.76	0.39	Afri	0.09	0.02
BI=Behavioural intention, AAT-PRS=Awareness and Attitude towards PRS.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding willingness to participate in e-waste recycling with a point rewards system and accountability-government structures**

Table 7.42 indicates that the effect size between Afrikaans and African speaking respondents leaned towards a medium effect ($d=0.40$). African language respondents ($M=4.38$, $SD=0.73$) indicated a higher degree of willingness to participate in a point rewards system to dispose of e-waste compared to Afrikaans speaking respondents ($M=4.08$, $SD=0.76$).

The effect size between English speaking respondents and African language respondents leaned towards a medium effect ($d=0.43$). African language respondents ($M=4.38$, $SD=0.73$) indicated a higher degree of willingness to participate in a point rewards system to dispose of e-waste compared to English speaking respondents ($M=4.05$, $SD=0.77$). In general, respondents speaking African languages were more positive to become part of a point reward system compared to respondents from the other two languages.

Table 7.42: Post-hoc tests on languages and factors “Willingness to Participate in e-waste recycling with a point rewards system” and “Accountability- Government Structures”

WP-PRS					Acc-GS				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
4.08	0.76	Afr			3.99	1.02	Afr		
4.05	0.77	Eng	0.03		3.92	1.00	Eng	0.07	
4.38	0.73	Afri	0.40	0.43	3.98	1.10	Afri	0.00	0.06
WP-PRS=Willingness to participate in e-waste recycling with a point rewards system, Acc-GS=Accountability-Government structures.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding accountability- producer to consumer and willingness towards the payment of a recycling fee**

Table 7.43 indicates that the effect size between Afrikaans and African speaking respondents leaned towards a medium effect ($d=0.45$). African language respondents ($M=3.00$, $SD = 0.82$) indicated a higher degree of willingness to pay a recycling fee compared to Afrikaans speaking respondents ($M=2.63$, $SD=0.79$).

The effect size between English speaking respondents and African language respondents leaned towards a medium effect ($d=0.46$). African language respondents ($M=3.00$, $SD=0.82$) indicated a higher degree of willingness to pay a recycling fee compared to English speaking respondents ($M=2.62$, $SD=0.80$). In general, respondents speaking African languages are willing to pay a little more towards a recycling fee, which can be used for e-waste recycling.

Table 7.43: Post-hoc tests on languages and factors “Accountability-Producer to Consumer” and “Willingness towards the payment of a recycling fee”

Acc-PtC					WTPRF				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
4.01	0.82	Afr			2.63	0.79	Afr		
4.03	0.76	Eng	0.01		2.62	0.80	Eng	0.02	
4.15	0.79	Afri	0.17	0.16	3.00	0.82	Afri	0.45	0.46
Acc-PtC=Accountability-Producer to Consumer, WTPRF=Willingness towards the payment of a recycling fee.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- ***Language group comparison regarding dispose with ordinary garbage and dispose along with separated waste***

Table 7.44 indicates the effect sizes but as they are lower than 0.35 they will not be discussed.

Table 7.44: Post-hoc tests on languages and factors “Dispose with ordinary garbage” and “Dispose along with separated waste”

D1					D2				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
0.28	0.45	Afr			0.22	0.42	Afr		
0.27	0.45	Eng	0.00		0.22	0.42	Eng	0.01	
0.41	0.50	Afri	0.28	0.28	0.26	0.44	Afri	0.09	0.08
D1=Dispose with ordinary garbage, D2=Dispose along with separated waste.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding dispose of e-waste at a collection point specific for electronic-waste and return to the store where purchased**

Table 7.45 indicates that the effect size between English speaking respondents and African language respondents leaned towards a medium effect ($d=0.39$). A higher percentage of English speaking respondents ($M=0.32$, or 32% of respondents, $SD=0.47$) indicated they would rather dispose of e-waste at a collection point specific for electronic-waste compared to African language speakers ($M=0.14$, or 14% of respondents, $SD=0.35$).

Table 7.45: Post-hoc tests on languages and factors “Dispose of it at a collection point specific for electronic-waste” and “Take it to a specific collection point as indicated by the manufacturer”

D3					D4				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
0.29	0.46	Afr			0.05	0.21	Afr		
0.32	0.47	Eng	0.06		0.06	0.25	Eng	0.0	
0.14	0.35	Afri	0.34	0.39	0.04	0.19	Afri	0.0	0.11
D3=Dispose of it at a collection point specific for electronic-waste. D4=Take it to a specific collection point as indicated by the manufacturer.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding returning e-waste to the store where purchased and donation it to a charity institution**

Table 7.46 indicates the effect sizes but as they are lower than 0.35 they will not be discussed.

Table 7.46: Post-hoc tests on languages and factors “Return to the store where I purchased” and “Donated it to a charity institution”

D5					D6				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
0.04	0.20	Afr			0.25	0.43	Afr		
0.02	0.13	Eng	0.13		0.26	0.44	Eng	0.03	
0.05	0.22	Afri	0.03	0.15	0.13	0.33	Afri	0.29	0.31
D5= Return to the store where I purchased it, D6=Donated it to a charity institution.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- **Language group comparison regarding giving e-waste to other people who could use it or repair it for themselves and storing of e-waste it residences**

Table 7.47 indicates the effect sizes, but as they are lower than 0.35 they will not be discussed.

Table 7.47: Post-hoc tests on languages and factors “Give it to other people who could use it or repair it for themselves” and “Store it at my residence”

D7					D8				
			Effect size					Effect size	
M	SD	Lan	Afr	Eng	M	SD	Lan	Afr	Eng
0.52	0.50	Afr			0.25	0.44	Afr		
0.49	0.50	Eng	0.06		0.15	0.36	Eng	0.24	
0.46	0.50	Afri	0.11	0.05	0.24	0.43	Afri	0.04	0.21
D7=Give it to other people who could use it or repair it for themselves, D8= Store it at my residence.									
Lan=Language, Afr=Afrikaans, Eng=English, and Afri=African languages, M= Means, SD=Standard Deviation.									

- ***Conclusion regarding comparison between languages in terms of constructs***

The results reported above showed that there were statistically significant differences in personal convenience scores between Afrikaans speaking persons and African language users, and between English speaking persons and African language users.

There were statistically significant differences in willingness to participate in a point reward system scores between Afrikaans speaking persons and African language users, and between English speaking persons and African language users. There were statistically significant differences in willingness to pay a recycle fee scores between Afrikaans speaking persons and African language users, and between English speaking persons and African language users. There was statistically significant difference in disposal at a collection point specific for electronic waste scores between English speaking persons and African language users. Overall, African language speakers were more willing to participate in a point reward system, showed a higher willingness to pay a recycling fee, and had less means and time to dispose e-waste. English speaking persons showed a higher degree of willingness compared to African language users to dispose at collection points specific for e-waste.

7.10 SPEARMAN'S RANK ORDER CORRELATIONS

Correlation analysis is used to describe the strength and direction of the linear relationship between two variables (Pallant, 2011:103). In this section, the correlation coefficient values obtained through the Spearman Rank Order Correlation were indicated and interpreted. Different authors suggest different interpretations for the values between 0 and 1; the following guidelines are suggested: $r=0.10$ (Small), $r=0.30$ (Medium), and $r=0.50$ (Large), (Cohen, 1988:79-81).

7.10.1 Correlation coefficient on demographic variables

The relationship between the demographic variables (age, monthly income, and education) was compared with the different factors in the next four tables. Only small correlation coefficients were detected and discussed.

Table 7.48 depicts the correlation coefficient between the remaining demographic variables and the factors which were analysed. Although most of these correlations were small, those statistically significant (bold values) will be discussed in the sections to follow.

Table 7.48: Correlation Coefficient between demographic variables and factors

Factor	Demographic variables		
	Age	Monthly income	Education level
Environmental awareness (EA)	0.175**	0.03	0.080
Attitude towards e-waste recycling (ATR)	0.118**	-0.04	0.028
Norms and publicity (NP)	0.01	-0.02	-0.085
Cost of recycling (CoR)	-0.091*	-0.109*	-0.081
Personal convenience of e-waste recycling (PC)	0.247**	0.116**	0.086
Convenience of facilities (CoF)	0.00	0.00	0.042
Behavioural intention (BI)	0.120**	0.03	0.069
Awareness and attitude towards PRS (AAT-PRS)	0.02	-0.01	0.028
Willingness to participate in e-waste recycling with a point rewards system (WP-PRS)	-0.241**	-0.199**	-0.016
Accountability- Government structures (Acc-GS)	-0.102*	-0.112*	-0.058
Accountability- producer to consumer (Acc-PtC)	-0.117**	-0.05	0.060
Willingness towards the payment of a recycling fee (WTPRF)	-0.06	-0.03	0.031
Dispose with ordinary garbage (D1)	-0.108*	0.00	-0.063
Dispose along with separated waste (D2)	0.117**	0.02	-0.014
Dispose of it at a collection point specific for electronic-waste (D3)	0.07	0.09	0.099*
Take it to a specific collection point as indicated by the manufacturer (D4)	-0.03	-0.04	0.053
Return to the store where I purchased it (D5)	-0.05	-0.05	0.028
Donated it to a charity institution (D6)	0.01	0.08	0.090*
Give it to other people who could use it or repair it for themselves (D7)	0.00	0.03	-0.001
Store it at my residence (D8)	-0.05	-0.08	0.030
**. Correlation is significant at the 0.01 level (2-tailed).			
* . Correlation is significant at the 0.05 level (2-tailed).			

- **Statistically significant correlations between age and the factors**

Table 7.49 indicates the statistically significant correlations between age and the factors. The small, positive correlation coefficients indicates that older persons are more concerned about environmental issues, have a more positive attitude and a higher degree of intent to contribute towards recycling e-waste, are more willing to dispose of e-waste; get information on correct disposal methods; share information with friends, and are more prone to dispose e-waste with separate waste compared to younger respondents.

The medium, positive correlation coefficient indicates older persons have more time and means (e.g. transport) to dispose large and small e-waste items compared to younger respondents. The small, negative correlation coefficients indicates older persons are less concerned about costs to recycle e-waste, are less supportive of government structures taking charge of e-waste recycling, are less supportive of the producers, retailers, and consumers taking charge of e-waste recycling, and are less prone to disposal of e-waste with ordinary garbage compared to younger respondents. The medium, negative correlation coefficient indicate that older persons are less interested in being rewarded by means of a point reward system when disposing e-waste compared to younger respondents.

Table 7.49: Correlation Coefficient between age and the factors

Factor	Correlation Coefficient	P
Environmental awareness	0.175**	0.00
Attitude towards e-waste recycling	0.118**	0.01
Cost of recycling	-0.091*	0.04
Personal convenience of e-waste recycling	0.247**	0.00
Behavioural intention	0.120**	0.01
Willingness to participate in e-waste recycling with a point rewards system	-0.241**	0.00
Accountability- Government structures	-0.102*	0.02
Accountability- producer to consumer	-0.117**	0.01
Dispose with ordinary garbage	-0.108*	0.01
Dispose along with separated waste	0.117**	0.01
**. Correlation is significant at the 0.01 level (2-tailed).		
*. Correlation is significant at the 0.05 level (2-tailed).		

- **Statistically significant correlations between monthly income and the factors**

From Table 7.50 the small, negative correlation coefficients indicates persons with higher incomes are less concerned about the cost to recycle and more willing to spend money on recycling e-waste, are less interested in being rewarded by means of a point reward system when disposing of e-waste, and are less supportive of government structures taking charge of e-waste recycling compared to persons with lower incomes.

The small, positive correlation coefficient indicates that persons with higher incomes have more time and the means (e.g. transport) to dispose of large and small e-waste items compared to persons with lower incomes.

Table 7.50: Correlation Coefficient between monthly income and factors

Factor	Correlation Coefficient	<i>P</i>
Cost of recycling (CoR)	-0.109*	0.01
Personal convenience of e-waste recycling (PC)	0.116**	0.01
Willingness to participate in e-waste recycling with a point rewards system (WP-PRS)	-0.199**	0.00
Accountability- Government structures (Acc-GS)	-0.112*	0.01
**. Correlation is significant at the 0.01 level (2-tailed).		
*. Correlation is significant at the 0.05 level (2-tailed).		

- **Statistically significant correlations between education levels and the factors**

From Table 7.51 the small, positive correlation coefficients indicates that persons with higher education levels prefer to dispose of e-waste at collection points designed to accept e-waste, and prefer to dispose e-waste through a charity institution who can again use the items compared to participants with lower education levels.

Table 7.51: Correlation Coefficient between education levels and factors

Factor	Correlation Coefficient	P
Dispose of it at a collection point specific for electronic-waste (D3)	0.099*	0.024
Donated it to a charity institution (D6)	0.090*	0.040
**. Correlation is significant at the 0.01 level (2-tailed).		
*. Correlation is significant at the 0.05 level (2-tailed).		

7.10.2 Correlation coefficient between constructs

The relationships between the different constructs were compared in the next six tables (Table 7.52 to Table 7.57). Only the medium ($r > 0.3$) and large ($r > 0.5$) correlation coefficients will be discussed. The small correlation coefficients are only indicated on the tables but will not be discussed. For efficient use of table space, abbreviations of the constructs were used and explained at the bottom of the table.

The relationship between environmental awareness and attitude towards e-waste recycling was determined using Spearman's two tailed Sigma tests as seen in Table 7.52. There was a large, positive correlation between the two factors, $r = 0.59$. Respondents who indicated they were concerned about the environment (Environmental awareness) also indicated they were in support of a formal e-waste collection and recycling system which would enable the reduction of harmful e-waste (Attitude towards e-waste recycling). The setting up of a formal collection and recycling system would address the environment concern of South African respondents. The opposite was however also true, meaning the respondents who indicated they were not concerned about the environment (Environmental awareness) also indicated they were not in support of a formal e-waste collection and recycling system which would enable the reduction of harmful e-waste (Attitude towards e-waste recycling). This group is problematic and should be informed

of the environmental dangers associated with incorrect e-waste disposal through the media and dedicated e-waste legislation. This would probably convince them to support e-waste recycling.

The relationship between environmental awareness and behaviour intention was determined using the Spearman's two-tailed Sigma tests as seen in Table 7.52. There was a medium, positive correlation between the two factors, $r = 0.468$. Respondents who indicated they were concerned about the environment (Environmental awareness) also indicated they were willing to spend time to dispose of e-waste, inform their friends, and learn more about appropriate disposal methods (Behaviour intention). Respondents are therefore aware the environment needs to be protected and are willing to go the extra mile to contribute to environmental protection. The opposite is however also true, meaning the respondents who indicated they were not concerned about the environment (Environmental awareness) also indicated they were not willing to spend time to dispose of e-waste, inform their friends, or learn about appropriate disposal methods (Behaviour intention). This group is problematic and should be informed of the environmental dangers associated with incorrect e-waste disposal through the media and dedicated e-waste legislation. This would probably convince them to support e-waste recycling by spending time to dispose of e-waste, inform their friends, and learn more about appropriate disposal methods.

The relationship between attitude towards e-waste recycling and behaviour intention was determined using Spearman's two-tailed Sigma tests as seen in Table 7.52. There was a medium, positive correlation between the two factors, $r = 0.473$. Respondents who indicated they were in support of a formal e-waste collection and recycling system, which would enable the reduction of harmful e-waste (Attitude towards e-waste recycling), also indicated willingness to spend time to dispose of e-waste, inform their friends, and learn more about appropriate disposal methods (Behaviour intention). A formal collection and recycling system would thus be supported from respondents willing to contribute to environmental protection.

Respondents who indicated they were not in support of a formal e-waste collection and recycling system (Attitude towards e-waste recycling) also indicated they were not willing to spend time to dispose of e-waste, inform their friends, and learn more about

appropriate disposal methods (Behaviour intention). This group is problematic and should also be informed of the environmental dangers associated with incorrect e-waste disposal through the media and dedicated e-waste legislation. This would probably convince them to support e-waste recycling by spending time to dispose of e-waste, inform their friends, and learn more about appropriate disposal methods.

The relationship between norms and publicity and convenience of facilities was determined using Spearman's two-tailed Sigma tests as seen in Table 7.52. There was a medium, positive correlation between the two factors, $r = 0.369$. Respondents indicated that people generally do not participate in e-waste recycling, there were insufficient laws and regulations governing e-waste, and the media does not publish relevant or enough information on e-waste recycling (Norms and publicity, $M=2.1$). This correlates with the responses which indicate that recycling channels are not enough and not close to where they stay (Convenience of facilities, $M=1.94$). The setting up of formal e-waste recycling channels, the introduction of dedicated e-waste legislation, and the spreading of information through the media would contribute to e-waste recycling. The introduction of collection points close to neighbourhoods is therefore needed. The media should inform the public of the collection points, the environmental dangers, and punitive measures should the public not comply with legislation.

The relationship between cost of recycling and personal convenience was determined using Spearman's two-tailed Sigma tests as seen in Table 7.52. There was a medium, negative correlation between the two factors, $r = -0.322$. Respondents who indicated travelling costs, time spent, and handling charges would be low to dispose e-waste (Cost of recycling) also indicated they have time and transport to deliver small and large e-waste items to disposal points (Personal convenience). The opposite was however also true, meaning the respondents who thought that travelling time and cost to dispose of e-waste were high, indicated they do not have the time or transport to take e-waste to collection points. This group is problematic and will only be convinced if facilities are close to where they stay, or processes are in place to make it easier for them to dispose of e-waste.

The relationship between personal convenience and behaviour intention was determined using Spearman's two-tailed Sigma tests as seen in Table 7.52. There was a large,

positive correlation between the two factors, $r = 0.497$. Respondents who indicated they have time and transport to deliver small and large e-waste items to disposal points (Personal convenience) also indicated they are willing to spend time to dispose of e-waste, inform their friends, and learn more about appropriate disposal methods (Behaviour intention). The opposite was however also true, meaning respondents who indicated they do not have time or transport to deliver small and large e-waste items to disposal points (Personal convenience) also indicated they are not willing to spend time to dispose of e-waste, inform their friends, or learn more about appropriate disposal methods (Behaviour intention). Again, this group is problematic and will only be convinced if facilities are close to where they stay, or processes are in place to make it easier for them to dispose of e-waste.

Table 7.52: Correlation coefficient between the factors EA, ATR, NP, CoR, PC, CoF and BI

Factors	EA	ATR	NP	CoR	PC	CoF	BI
EA	1.000						
ATR	.590**	1.000					
NP	-.130**	-.129**	1.000				
CoR	-0.083	-0.060	0.039	1.000			
PC	.227**	.251**	-.088*	-.322**	1.000		
CoF	-0.061	-0.045	.369**	-.112*	0.038	1.000	
BI	.468**	.473**	-.187**	-.223**	.497**	-0.075	1.000
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
EA=Environmental awareness, ATR=Attitude towards e-waste recycling, NP=Norms and publicity, CoR=Cost of recycling, PC=Personal convenience of e-waste recycling, CoF=Convenience of facilities, and BI=Behavioural intention.							

In Table 7.53 only small correlation coefficients are found and will not be discussed.

Table 7.53: Correlation coefficient between factors EA, ATR, NP, CoR, PC, CoF, BI, AAT-PRS, WP-PRS, Acc-GS, Acc-PtC, WTPRF, D1, and D2

Factors	AAT-PRS	WP-	Acc-GS	Acc-	WTPRF	D1	D2
EA	0.040	0.136**	0.112*	0.239**	0.160**	-0.188**	0.110*
ATR	0.006	0.245**	0.224**	0.271**	0.175**	-0.128**	0.057
NP	-0.120**	-0.150**	-0.099*	-0.108*	0.069	-0.058	0.058
CoR	-0.013	0.105*	0.044	-0.026	-0.028	0.124**	0.044
PC	0.005	0.051	-0.056	0.025	0.077	-0.139**	0.050
CoF	-0.018	-0.098*	-0.113*	-0.062	0.034	-0.119**	0.070
BI	0.092*	0.279**	0.150**	0.247**	0.182**	-0.151**	0.053
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
EA=Environmental awareness, ATR=Attitude towards e-waste recycling, NP=Norms and publicity, CoR=Cost of recycling, PC=Personal convenience of e-waste recycling, CoF=Convenience of facilities, BI=Behavioural intention, AAT-PRS= Awareness and attitude towards PRS, WP-PRS=Willingness to participate in e-waste recycling with a point rewards system, Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer, WTPRF=Willingness towards the payment of a recycling fee, D1=Dispose with ordinary garbage, D2=Dispose along with separated waste.							

In Table 7.54 only small correlation coefficients are found and will not be discussed.

Table 7.54: Correlation coefficient between factors EA, ATR, NP, CoR, PC, CoF, BI, D3, D4, D5, D6, D7, and D8

Factors	D3	D4	D5	D6	D7	D8
EA	0.136**	0.094*	0.084	0.033	0.052	0.023
ATR	0.121**	0.047	0.014	0.017	-0.043	-0.016
NP	0.120**	0.071	-0.001	-0.026	-0.051	-0.107*
CoR	-0.189**	0.027	-0.033	-0.027	-0.044	0.060
PC	0.201**	-0.010	-0.011	0.085	0.058	-0.036
CoF	0.207**	0.129**	-0.010	0.098*	-0.019	-0.085
BI	0.160**	0.027	-0.002	0.002	0.024	0.060
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						
EA=Environmental awareness, ATR=Attitude towards e-waste recycling, NP=Norms and publicity, CoR=Cost of recycling, PC=Personal convenience of e-waste recycling, CoF=Convenience of facilities, BI=Behavioural intention, D3=Dispose of it at a collection point specific for electronic-waste, D4=Take it to a specific collection point as indicated by the manufacturer, D5=Return to the store where I purchased it, D6=Donated it to a charity institution, D7=Give it to other people who could use it or repair it for themselves, and D8=Store it at my residence.						

The relationship between accountability-Government structures and accountability-producer to consumer was investigated and the correlation coefficient was determined using Spearman's two-tailed Sigma tests as seen in Table 7.55. There was a medium, positive correlation between the two variables (factors), $r=0.394$. Respondents who indicated the Government structures (Municipalities and Government) must be involved in recycling initiatives, also indicated the producer (manufacturer), retailer, and consumer must be involved in recycling activities. This correlation is an indication that the South African consumer (respondents) agrees that e-waste recycling is not the responsibility of one group, but the responsibility of all.

Table 7.55: Correlation Coefficient between factors AAT-PRS, WP-PRS, Acc-GS, Acc-PtC, WTPRF, D1, and D2

Factors	AAT-PRS	WP-PRS	Acc-GS	Acc-PtC	WTPRF	D1	D2
AAT-PRS	1.000						
WP-PRS	0.152**	1.000					
Acc-GS	0.033	0.286**	1.000				
Acc-PtC	0.090*	0.278**	0.394**	1.000			
WTPRF	-0.003	0.137**	0.103*	0.224**	1.000		
D1	0.002	0.008	0.012	-0.067	-0.053	1.000	
D2	-0.064	-0.011	0.113*	0.055	-0.024	-0.163**	1.000
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
AAT-PRS= Awareness and attitude towards point reward system, WP-PRS=Willingness to participate in e-waste recycling with a point rewards system, Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer, WTPRF=Willingness towards the payment of a recycling fee, D1=Dispose with ordinary garbage, D2=Dispose along with separated waste.							

In Table 7.56 only small correlation coefficients are found and will not be discussed.

Table 7.56: Correlation Coefficient between factors AAT-PRS, WP-PRS, Acc-GS, Acc-PtC, WTPRF, D1, D2, D3, D4, D5, D6, D7, and D8

Factors	D3	D4	D5	D6	D7	D8
AAT-PRS	-0.009	-0.007	-0.016	0.077	0.132**	0.131**
WP-PRS	0.007	0.093*	-0.025	0.044	0.029	0.101*
Acc-GS	-0.037	0.036	0.046	-0.038	-0.101*	-0.034
Acc-PtC	0.121**	0.118**	0.063	0.042	-0.002	0.054
WTPRF	0.075	0.100*	0.005	0.001	0.005	0.018
D1	-0.272**	-0.080	0.006	0.005	-0.106*	-0.036
D2	0.050	.094*	0.062	0.086	-0.035	0.055
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						
AAT-PRS= Awareness and attitude towards PRS, WP-PRS=Willingness to participate in e-waste recycling with a point rewards system, Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer, WTPRF=Willingness towards the payment of a recycling fee, D1=Dispose with ordinary garbage, D2=Dispose along with separated waste, D3=Dispose of it at a collection point specific for electronic-waste, D4=Take it to a specific collection point as indicated by the manufacturer, D5=Return to the store where I purchased it, D6=Donated it to a charity institution, D7=Give it to other people who could use it or repair it for themselves, and D8=Store it at my residence.						

The relationship between “Donated it to a charity institution” and “Give it to other people who could use it or repair it for themselves” was investigated and the correlation coefficient was determined using Spearman’s two-tailed Sigma tests as seen in Table 7.57. There was a medium, positive correlation between the two variables (factors), $r = 0.336$. Respondents who indicated they donated it to a charitable institution (Donated it to a charity institution) also indicated they gave it to other people who could use it or repair it for themselves (Give it to other people who could use it or repair it for themselves). This correlation is an indication that this group of respondents want to dispose by helping others. The intentions are good, but the result is that the e-waste items become the problem of someone else if it cannot be repaired or when it finally breaks down. A formal collection, recycling, and disposal method would reduce this disposal method, which could lead to better recycling and disposal results.

Table 7.57: Correlation Coefficient between factors D3, D4, D5, D6, D7, and D8

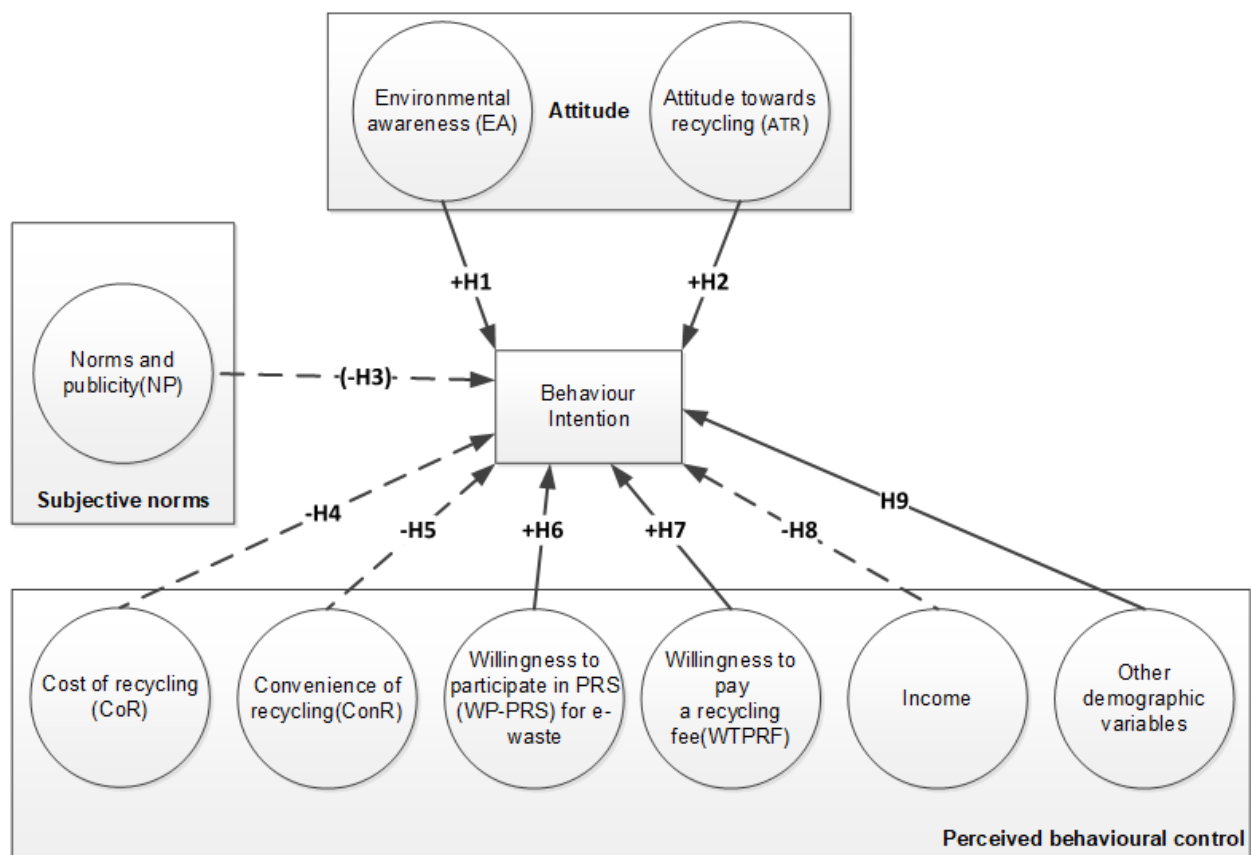
Factors	D3	D4	D5	D6	D7	D8
D3	1.000					
D4	0.232**	1.000				
D5	0.113**	0.106*	1.000			
D6	0.190**	0.168**	0.137**	1.000		
D7	0.003	0.071	0.091*	0.336**	1.000	
D8	-0.079	0.049	-0.007	0.135**	0.130**	1.000
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						
D3=Dispose of it at a collection point specific for electronic-waste, D4=Take it to a specific collection point as indicated by the manufacturer, D5=Return to the store where I purchased it, D6=Donated it to a charity institution, D7=Give it to other people who could use it or repair it for themselves, D8=Store it at my residence.						

Care was taken to make sure the constructs were reliable and factor analysis was done. The next step is to evaluate the proposed conceptual model with the data that has been collected.

7.11 STRUCTURAL EQUATION MODELLING (SEM) TO INVESTIGATE THE EFFECT OF EA, ATR, NP, COR, CONR, WP-PRS, WTPRF, AND DEMOGRAPHIC FACTORS ON BEHAVIOUR INTENTION (BI)

Figure 7.8 depicts the hypothesized model as developed in Chapter 4. The preceding sections discussed the statistical tests conducted. In the sections to follow, a hypothesised model is developed using SEM. Pallant (2011:104-105) describes SEM as a sophisticated technique that allows researchers to test different models regarding the interrelationships among a set of variables. It allows one to test the overall fit of the data to the model by evaluating the significance of each of the independent variables in the model; this is based on multiple regression techniques. It also allows one to compare alternative models (Pallant, 2011:104-105).

Figure 7.8: Hypothesized model for the relationships between constructs that contribute to positive e-waste behaviour intentions of consumers



The data in Table 7.58 has been discussed in previous sections (Section 7.6.3.1 and 7.6.3.2). This table shows the correlations between Behaviour Intention (BI) and all the factors and the “Age” variable. Non-significant correlation coefficients ($P > 0.05$) were not included in the final proposed model as no correlation existed. The correlation coefficients which were used in the final SEM had r values from 0.1 and higher. The lowest usable variable was Age ($r = 0.120$, small) and the biggest was personal convenience ($r = 0.497$, large). The factors convenience of facilities, awareness and attitude towards PRS, dispose along with separated waste, take it to a specific collection point as indicated by the manufacturer, return to the store where I purchased it, donated it to a charity institution, give it to other people who could use it or repair it for themselves, and store it at my residence were not used due to the insignificant correlation values.

Table 7.58: Correlation Coefficients (r) and statistical significance (P) between Behaviour Intention (BI) and the rest of the factors

Factors		Age	EA	ATR	NP	CoR	PC
BI	r	0.120**	0.468**	0.473**	-0.187**	-0.223**	0.497**
	P	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
	Factors	CoF	AAT-PRS	WP-PRS	Acc-GS	Acc-PtC	WTPRF
	r	-0.075	0.092*	0.279**	0.150**	0.247**	0.182**
	P	0.090	0.037	<0.001	0.001	<0.001	<0.001
	Factors	D1	D2	D3	D4	D5	D6
	r	-0.151**	0.053	0.160**	0.027	-0.002	0.002
	P	0.001	0.232	<0.001	0.537	0.970	0.965
	Factors	D7	D8				
	r	0.024	0.060				
	P	0.591	0.169				
** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed). EA=Environmental awareness, ATR=Attitude towards e-waste recycling, NP=Norms and publicity, CoR=Cost of recycling, PC=Personal convenience of e-waste recycling, CoF=Convenience of Facilities, BI=Behavioural intention, AAT-PRS= Awareness and attitude towards PRS, WP-PRS=Willingness to participate in e-waste recycling with a point rewards system, Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer, WTPRF=Willingness towards the payment of a recycling fee, D1=Dispose with ordinary garbage, D2=Dispose along with separated waste, D3=Dispose of it at a collection point specific for electronic-waste, D4=Take it to a specific collection point as indicated by the manufacturer, D5=Return to the store where I purchased it, D6=Donated it to a charity institution, D7=Give it to other people who could use it or repair it for themselves, and D8=Store it at my residence.							

7.12 UNIQUE CONTRIBUTIONS TOWARDS BEHAVIOUR INTENTION (BI)

Because the predictor variables are not independent and also correlate with each other, not all of them had a unique contribution to BI – even though they had correlated with BI. In the tables to follow (Table 7.59 and Table 7.60) the unique contributions towards Behaviour Intention are given by Standardised Regression Weights and will be highlighted and discussed. This will indicate which factors were statistically significant and which factors had the highest contribution towards a final proposed model.

In Table 7.59, the Standardised Regression Weights showed the unique contributions to behaviour intention. For a factor to have a unique contribution, the *P* values must be smaller than 0.05. Five of the factors (Personal convenience, attitude towards e-waste recycling, environmental awareness, accountability, and willingness to participate in e-waste recycling with a point rewards system) had a unique contribution. One factor (Cost of recycling) made a borderline unique contribution. Two of the factors (Age; norms and publicity) did not make a significant unique contribution to behaviour intention.

Table 7.59: Unique contributions towards behaviour intention and Standardised Regression Weights - Age included

Behaviour intention	<i>P</i>	Standardised Regression Weights
Unique contribution		
Personal convenience	***	0,425
Attitude towards e-waste recycling	***	0,223
Environmental awareness	***	0,188
Accountability (Acc-GS and Acc-PtC)	0,018	0,179
Willingness to participate in e-waste recycling with a point rewards system	0,023	0,106
Borderline unique contribution		
Cost of recycling	0,054	0,077
Insignificant unique contribution		
Age	0,462	0,027
Norms and publicity	0,477	0,026
<i>Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer</i>		

Personal convenience (0.425), made the largest contribution to behaviour intention. Attitude towards e-waste recycling (0.223) was the second biggest contributor and environmental awareness (0,188) the third biggest contributor.

Age (0.027), norms and publicity (-0.026), and cost of recycling (-0.077) were the lowest contributors.

Due to the statistical significance of the correlation of Age with behaviour intention, the variable was included in the first model, however the regression weight of age was not statistically significant and was omitted from the SEM model, as it was the only biographical variable in the model, and the new model was then refitted.

In Table 7.60, the calculated values showed the unique contributions to behaviour intention without age. For a factor to have a unique contribution, the *P* values must be smaller than 0.05. Table 7.60 illustrated the unique contribution of the factors without the inclusion of age, due to it being removed from the final conceptual model as the regression weight of age was not statistically significant in the SEM.

Table 7.60: Unique contributions towards behaviour intention and Standardised Regression Weights - Age excluded

Behaviour intention	<i>P</i>	Standardised Regression Weights
Personal convenience	***	0.429
Attitude towards e-waste recycling	***	0.226
Environmental awareness	***	0.191
Accountability (Acc-GS and Acc-PtC)	0.020	0.174
Willingness to participate in e-waste recycling with a point rewards system	0.031	0.100
Norms and publicity	0.467	-0.027
Cost of recycling	0.055	-0.076
*** indicate $P < 0.001$, thus statistically significant		
Acc-GS=Accountability-Government structures, Acc-PtC=Accountability-producer to consumer		

The Standardised Regression Weights without age indicated small changes to the factor contributions towards BI. The biggest contribution to behaviour intention remained personal convenience (0.429), with attitude towards e-waste recycling (0.226) the second biggest contributor and environmental awareness (0.191) the third biggest contributor.

7.13 ESTIMATION OF THE HYPOTHESISED RESEARCH MODEL

Estimation of the hypothesised research model implies evaluating the model. This is done to determine whether the model explains the data. Often initial models do not fit the data properly and have to be adjusted in this process (Hancock & Mueller, 2010).

For the current study, the model fit was evaluated considering the Minimum Sample Discrepancy divided by Degrees of Freedom (CMIN/DF), Comparative Fit Index (CFI) and The Root Mean Square Error of Approximation (RMSEA).

The Chi-square test has the power to detect even trivial deviations from the proposed model, and for this reason it is viewed by some as an overly strict indicator of model fit (Hancock & Mueller, 2010). For this reason, it was suggested the Chi-square test statistic be divided by the Degrees of Freedom (Mueller, 1996). Some interpret CMIN/DF ratios as high as 3, 4 or even 5 as still representing a good model fit, but the interpretation of the size of this value depends to a large extent on the viewpoint of the investigator (Mueller, 1996).

Values of above 0.9 are indicative of a good overall fit for a CFI (Mueller, 1996). Models with RMSEA values of 0.10 and larger should not be accepted (Blunch, 2008); while lower RMSEA values indicate better fit in a model.

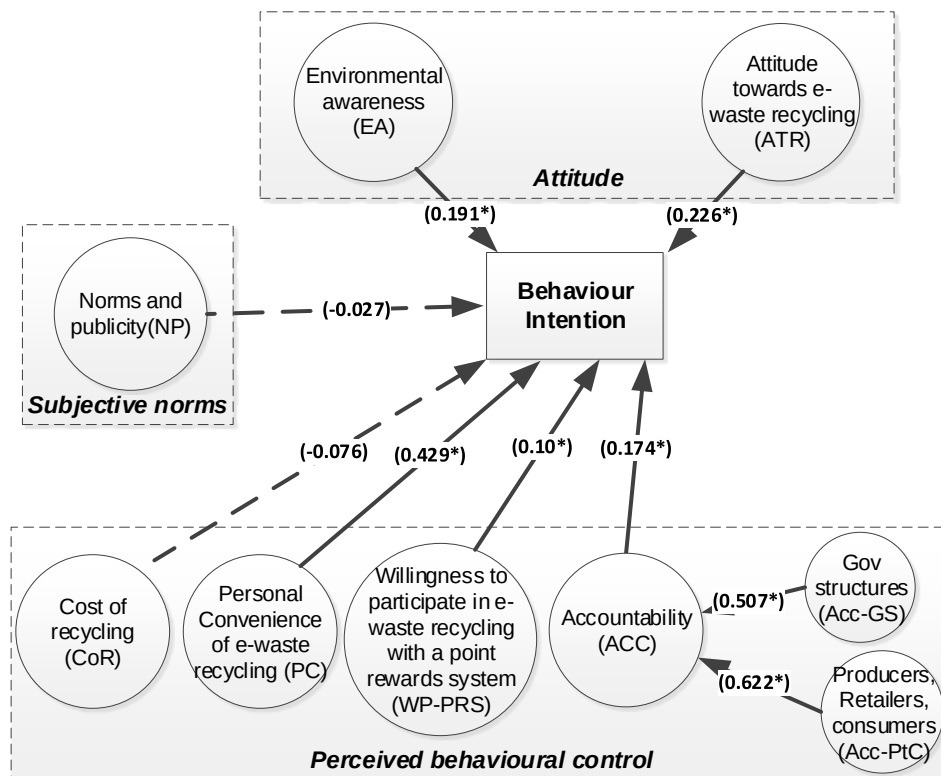
The thresholds for these three model fit indices and the values for a model with age include and excluded are indicated in Table 7.61. The model fit indices were better with age excluded (CMIN/DF = 3.897; CFI = 0.948; RMSEA = 0.075) than age with age included (CMIN/DF = 5.217; CFI = 0.899; RMSEA = 0.090). Age was thus excluded to achieve an overall good model fit.

Table 7.61: Goodness of fit - Age included and age excluded

Measurement	Model-Age included	Model-Age excluded	Recommended threshold	Source
CMIN/DF	5.217	3.897	<5.000	Mueller, 1996
CFI	0.899	0.948	>0.9	Mueller, 1996
RMSEA	0.090	0.075	>0.10	Blunch, 2008
90% Confidence interval for RMSEA	[0.077; 0.103]	[0.059; 0.090]		

The output of the SEM for the hypothesised model is depicted in Figure 7.9.

Figure 7.9: A model that depicts the determinants of e-waste recycling behaviour intentions of consumers with standardised regression weights



* Significant

The path analysis indicates some significant determinants of e-waste recycling behaviour intentions of consumers. No significant relations with BI were evident with norms and publicity while cost of recycling was borderline significant.

Significant relations with behaviour intention were evident between the personal convenience and e-waste recycling behaviour intentions; attitude towards e-waste recycling and e-waste recycling behaviour intentions; and environmental awareness and e-waste recycling behaviour intentions.

With all other factors remaining the same, an e-waste management programme should mostly focus on personal convenience. In urban areas, e-waste collection points should be enough and in close proximity from where residents stay; this would ensure that little time was spent on travelling to a site to dispose of small e-waste items. At the same time

it is important that a system be developed for the collection and disposal of large e-waste items, which would require minimum time and effort from consumers.

The next biggest contributor to have an effect of the behaviour intention of consumers is the attitude towards e-waste recycling. A formal organised e-waste collection and recycling system, where consumers are made aware of the pollution dangers, should encourage them to contribute to the reducing of the harmful effect of e-waste.

The environmental awareness of consumers was the next biggest contributor to the behaviour intention of consumers. The more conscious consumers were about environmental issues, the more concerned they would become and the bigger their contribution would be through their daily actions. The awareness focus should be specifically on e-waste, as this study indicates that there is no dedicated e-waste legislation or media coverage to make consumers aware of the e-waste problems.

Accountability from all sectors has also proven to be important, where the emphasis should be focused on the producer, retailer and consumer (Estimate = 0.622) as they are the primary custodian of the items that will become e-waste. Government structures (Estimate = 0.507) were also seen as an important component and legislation introduction should be the first priority.

The last statistical significant contributor to the behaviour intention of consumers was the willingness to participate in a point reward system. Although a limited number of respondents had knowledge about, or used point rewards, the introduction of such a system to reward consumers for returning e-waste must be explored and pilot project implemented to test the effectiveness.

This hypotheses set for the current study are presented in the following sections.

7.14 HYPOTHESIS TESTING OF THE DETERMINANTS OF E-WASTE RECYCLING BEHAVIOUR INTENTIONS OF CONSUMERS

The hypotheses in the study were tested at $p < 0.05$, based on sample data. A hypothesis test is used to make statistical decisions about a given population and it is a method to determine whether a statement about a characteristic of a population is rational (Sun, Djouani, Van Wyk, Wang & Siarry, 2014:90).

7.14.1 Hypothesis 1

H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.

The hypothesis was supported because environmental awareness had a significant correlation with 'Behavioural Intent' ($p < 0.001$). There was a medium, positive correlation between the two factors, $r = 0.468$ (see Table 7.58).

7.14.2 Hypothesis 2

H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.

The hypothesis was supported because attitude towards e-waste recycling had a significant correlation with 'Behavioural Intent' ($p < 0.001$). There was a medium, positive correlation between the two factors, $r = 0.473$ (see Table 7.58).

7.14.3 Hypothesis 3

H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.

The hypothesis was supported as norms and publicity had a significant negative correlation with 'Behavioural Intent' ($p < 0.001$). There was a small, negative correlation between the two factors, $r = -0.187$ (see Table 7.58).

7.14.4 Hypothesis 4

H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.

The hypothesis was supported because costs of recycling had a significant negative correlation with 'Behavioural Intent' ($p < 0.001$). There was a small, negative correlation between the two factors, $r = -0.223$ (see Table 7.58).

7.14.5 Hypothesis 5

H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.

The hypothesis was supported although convenience of recycling divided into two dimensions, namely personal convenience and convenience of facilities. Personal convenience had a significant correlation with behaviour intent ($p < 0.001$) and proved to be the biggest contributor to the SEM model. There was a large, positive correlation between the two factors, $r = 0.497$ (see Table 7.58). The construct showed a large correlation and focused on personal convenience. Respondents with available time and the means to dispose of small and large items showed a higher degree of willingness and intention to dispose of e-waste. The opposite is also true.

The second dimension convenience of facilities, had a non-significant correlation with 'Behavioural Intent' ($p = 0.090$) (see Table 7.58). The construct showed no significant results in terms of relationship with Behavioural Intent.

7.14.6 Hypothesis 6

H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.

The hypothesis was supported because willingness of residents to participate in a point rewards system had a significant correlation with 'Behavioural Intent' ($p < 0.001$). There was a small, positive correlation between the two factors, $r = 0.279$ (see Table 7.58).

The study revealed that urban consumers were generally not familiar with a PRS system and that they will not be persuaded to dispose of e-waste in this manner. The researcher, as well as many participants of the interviews which were conducted, were of the opinion that PRS (or some form of payment) would get e-waste released from rural residents. Rural residents were not included in the study and this reward system needs to be further investigated for such areas.

7.14.7 Hypothesis 7

H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.

The hypothesis was supported because willingness to pay a recycling fee had a significant correlation with behavioural intent ($p < 0.001$). There was a small, positive correlation between the two factors, $r = 0.182$ (see Table 7.58).

In line with most developing countries, South African urban consumers showed a willingness to pay a recycling fee. The statistical analysis however also indicated that 80.1% of South African urban consumers were willing to pay between 0 and 6% of the selling price towards a recycling fee.

7.14.8 Hypothesis 8

H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.

The hypothesis was not supported because income had a non-significant correlation with 'Behavioural Intent' ($p = 0.51$). There was a small, positive correlation between the two factors, $r = 0.03$ (see Table 7.48).

7.14.9 Hypothesis 9

H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

The hypotheses were partially supported as age had a significant correlation with behavioural intention, while gender and education had no correlation:

- An independent-samples t-test was conducted to compare the behavioural intention scores for males and females. There was no statistically significant difference ($p > 0.05$) in scores for males ($M=4.16$, $SD=0.74$) and females ($M=4.22$, $SD=0.72$; $t(514) = -0.91$, $p=0.362$, two-tailed) (see Table 7.23).
- Age had a significant correlation with behavioural intent ($p = 0.01$). There was a small, positive correlation between the two factors, $r = 0.120$ (see Table 7.48).
- Education had a non-significant correlation with 'Behavioural Intent' ($p=0.120$). There was a small, positive correlation between the two factors, $r=0.069$ (see Table 7.48).

7.15 CONCLUSION

Chapter 7 started with an analysis of the demographic profiles of the respondents and was followed by the descriptive statistics of the factors which were used. Factor analysis was done and the reliability factors determined. Cronbach Alpha values and KMO's showed the reliability. The effects of biographical variables on the factors and post hoc tests followed. This was done using T-tests, ANOVA tests, and Spearman's rank order correlation. The conceptual framework for the quantitative phase was then refined by using Standard Regression Weights and Structural Equation Modelling.

The biggest contributors to behavioural intention were personal convenience, environmental awareness, and attitude towards e-waste recycling. The chapter concluded with hypotheses testing based on the quantitative conceptual framework and the statistical results. In Chapter 8 the results from Chapter 6 (Qualitative phase-Interviews) and Chapter 7 (Quantitative phase-Statistical data) will be mixed to determine if there are convergent or divergent views.

CHAPTER 8- INTEGRATION FINDINGS AND DISCUSSION

8.1 INTRODUCTION

This chapter presents the integration phase of this empirical study. The chapter unfolds in the following way; firstly, it presents the integration of the qualitative and quantitative phases of the current mixed methods research study; secondly, the research objective and questions of the integration phase are presented; thirdly, the chapter looks into the integration levels and purpose; fourthly, the chapter presents the convergent design joint display and address the three research questions of the integration phase of the study.

8.2 INTEGRATION OF THE QUALITATIVE AND QUANTITATIVE PHASES OF THE CURRENT MIXED METHODS RESEARCH STUDY

Creswell and Plano Clark (2007:202) regard integration as a principal component of mixed method research interpreted it as the explicit interrelating of the qualitative and quantitative component of a mixed method study. Bazeley (2009:204) advises that integration requires interconnection in reaching a common theoretical or research goal. For this study, a convergent parallel mixed methods design was conducted to provide a comprehensive and complete understanding of the phenomena of e-waste in South Africa from the perspective of key stakeholders and consumers.

This empirical part of the study was implemented in three phases. The objective of the qualitative research phase of this study was to explore the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. The results for this objective were interpreted in Chapter 6. The objective of the quantitative research phase was to examine the drivers and inhibitors of e-waste recycling behaviour intentions of urban South African household e-waste consumers. The results for this objective were described in Chapter 7. Phase one and two were conducted in parallel, and once these phases were completed, the mixing of the results occurred. The research objective with accompanying research questions for the integration phase of the current study questions are presented in the following section.

8.3 RESEARCH OBJECTIVE AND QUESTIONS OF THE INTEGRATION PHASE

Research objective 3:

To advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) should be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South-Africa (qualitative results).

The main contributors to behavioural intention were personal convenience, attitude towards e-waste recycling and environmental awareness. All three factors had *P*-Values smaller than 0.001, showing statistically significant contributions towards behavioural intention. The Standardised Regression Weights of these three factors were also the highest contributors to the model: personal convenience=0.429, attitude towards e-waste recycling=0.226 and environmental awareness=0.191. The *P*-Values of accountability (Accountability-Government structures and accountability-producer to consumer) and willingness to participate in e-waste recycling with a point rewards system were 0.020 and 0.031 respectively, while the Standardised Regression Weights of the factors were 0.174 and 0.10 respectively. These two factors delivered a statistically significant but small contribution to behavioural intention (see Table 7.60 and Figure 7.9 in Chapter 7).

The integration phase focus specifically on the three biggest contributors to behavioural intention. Personal convenience (0.429) delivered the biggest contribution followed by attitude towards e-waste recycling (0.226) and environmental awareness (0.191).

To meet research objective 3 related to the integration phase, the following three research questions have to be answered.

- **Research questions:**

- RQ3a: How can personal convenience of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?
- RQ3b: How can attitude towards e-waste recycling of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

- RQ3c: How can environmental awareness of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

8.4 INTEGRATION LEVELS AND PURPOSE

Woolley (2009:7) argues that quantitative and qualitative components of a mixed methods study can be regarded as “integrated” to the level that these components are clearly linked to each other within a single study and in such a manner as to be reciprocally clarifying, thereby producing findings that are greater than the sum of the parts. Integration in the current mixed method research study was implemented at the design, interpretation and reporting levels. Integration on these levels are explained in the following sections.

8.4.1 Integration at the design level

Basic mixed methods design includes exploratory sequential, explanatory sequential, and convergent designs (Creswell & Plano Clark, 2007:20). Since a convergent parallel design was applied in the current study, integration at the design level involved independent collection and analysis of the qualitative and quantitative data at a similar time frame. This was then followed by an integrated analysis of the data collected.

8.4.2 Integration at interpretation and reporting level

Integration at the interpretation and reporting level for the current study was by done by creating joint displays. A joint display is a way to represent and facilitate integration of data through visual means (e.g. figure, table, matrix, or graph) to draw out new insights beyond the information gained from the separate quantitative and qualitative results (Fetters, Curry & Creswell, 2013:2137).

8.4.3 The purpose of the integration

Combining quantitative and qualitative research in the current study guided the development of a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in the South African context. The rationale for integration in the current study was to compare the data sets in order to determine which measures could be suggested for implementation (from the qualitative phase) to address personal convenience, attitude towards e-waste recycling, and environmental awareness of consumers towards disposal of e-waste (the quantitative phase).

8.5 CONVERGENT DESIGN JOINT DISPLAY

To represent integration, convergent design joint displays were created to allow integration of the quantitative results and qualitative findings (see Tables 8.1 to 8.3).

The quantitative results indicate the specific constructs, their mean (M) and standard deviation (SD) values, correlation coefficients (r) and calculated values of the unique contributions to consumers' behaviour intention with regards to e-waste.

The qualitative findings showed some selected quotations, participant numbers and the names of the categories.

The last aspect in the joint displays is the integration outcome. The integration outcomes were formulated to address the specific research questions (RQ3a, RQ3b RQ3c) of this phase. These will be presented as specific suggestions on how the main contributors to e-waste recycling behaviour intentions of consumers (personal convenience of consumers, consumers' attitude towards e-waste recycling, and consumers' environmental awareness) can be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South-Africa.

8.5.1 Integration regarding consumers' personal convenience and key stakeholders' views on convenience of mechanisms

Table 8.1 shows the joint display addressing research questions RQ3a. The findings depicted, and the integration will be presented in the subsequent sections.

Table 8.1: Joint display of consumers' personal convenience and key stakeholders' views on e-waste mechanisms

QUANTITATIVE RESULTS		
Construct	Personal Convenience	
Descriptive statistics	M	3.31
	SD	0.9
Correlation with behaviour intention	<i>r</i>	0.497**
	<i>P</i>	<0.001
Contributions towards behaviour intention	<i>P</i>	***
	Estimate	0.429
M=Mean, SD=Standard Deviation.		
. Correlation is significant at the 0.01 level (2-tailed), *. <i>P</i> <0.001		
QUALITATIVE FINDINGS		
Selected quotations	Participant numbers	Categories
"So I've got a collection, as you've mentioned, on a ... starting at a local residential by a suburb basis, by people having just to log onto the system via their cell phones, computer or laptop, pre-book a collection, specify on there what it is, and it will be come and collected there."	P2ES	Kerbside placement and disposal of small and large e-waste appliances
"It's a good idea [Referring to corporate collection points] if you've got a lot of people, then get people to collect at different collection points,"	P10GA	Convenience is the key to effective e-waste collection
"So, you'll have to establish some sort of mobile facility. That's not there always, but it's there maybe once a month, that can go in and then getting it out. So, at least you'll have a way of collecting it, and then taking it out."	P5GA	Authorised mobile e-waste collection
INTEGRATION OUTCOME		
Suggestions on how personal convenience of consumers be can be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South-Africa.		RQ3a

- **Quantitative results**

Convenience of recycling refers to consumers' perceptions of the processes required to recycle e-waste (Wang, Guo & Wang, 2016:852). The mean scores for personal convenience, as indicated in Table 8.1, confirm that consumers had an overall positive level of environmental awareness ($M=3.31$, $SD=0.9$). Furthermore, personal convenience had a significant correlation with behavioural intent ($p < 0.001$) with a medium, positive correlation between these two factors, $r= 0.497$ as reported for hypothesis 5 (see section 7.10.5 in Chapter 7). The standardised regression weight for personal convenience of 0.429 ($p < 0.001$), implies that this factor had the highest contribution towards behaviour intention (see Table 7.60 and Figure 7.9 in Chapter 7).

- **Qualitative results**

The important role of convenience in the recycling behaviour of households, as part of a successful e-waste management process in South Africa, was accentuated during the interviews with participants in the qualitative phase. The participants stressed that accessibility of e-waste collection points for households is an important issue to make e-waste collection for household consumers convenient in the South African context. Verbatim quotes reflecting the stakeholders' views on convenience of mechanisms are included in Table 8.1.

- **Integration and conclusion**

It is evident that the following existing practices for e-waste collection are not ideal and therefore require some modifications:

- The practice of households placing e-waste on the kerbside and in refuse bins is problematic and hazardous. This results in environmental- and health-related risks due to the cherry picking and unsafe practises that occur. Due to high crime rates and security measures, access to households and apartments in cities are limited and doorstep haggling to buy e-waste should not be allowed.
- The existing South African garden refuse sites are unsuitable for e-waste collection due to space availability as well as the lack of proper control and security after hours. Future municipal transfer stations should be built with recycling in mind, where knowledgeable personnel can accept and safely store recyclable materials. Transfer stations equipped to receive e-waste could thus contribute to convenience if placed within reasonable distances from neighbourhoods.

Several options could be suggested to assist and ensure that e-waste collection from consumers is effective and convenient:

- E-waste could be collected on specific days of the month at specific places. Identifying specific pick up sites could help to ensure that consumers take e-waste to these sites. These options should be properly communicated to consumers via suitable media in different areas. This regular collection method can also be implemented in rural areas and the countryside. Single transport trips, arranged by the transport section of the PRO, would make it cost-effective to travel long distances.
- An innovative technological “Call-to-collect” system could be introduced in urban areas. The purpose of a call-to-collect system is to collect large WEEE, such as stoves, fridges, freezers, and washing machines from households. It should be a web based system where consumers can arrange collections using the internet to make arrangements. A cellular application or normal phone call could also be used for this purpose. This will ensure that the large items can conveniently be removed. Safety of consumers is vital, and they need to be able to arrange the pick-ups with the PRO with safety precautions being a priority. This service should ideally be free for consumers to ensure cooperation.
- Corporate entities with the required infrastructure and capabilities should be encouraged and supported to collect household e-waste. The majority of e-waste consumers engage with their place of employment on a daily basis and it would be ideal if consumers could take disposable items to their workplace.
- Receptacles inside or outside shopping malls are needed as this is where consumers go for leisure activities and shopping. These receptacles should only be for small items, such as batteries, CFL bulbs, and printer cartridges.
- Outside receptacles, such as shipping containers, must be placed on the property of large retailer outlets, such as Makro. These outlets have enough space to place containers where there will be no interference with deliveries or parking space for customers. The container should be manned by PRO personnel to ensure the safety of consumers dropping off e-waste, as informal recyclers could be problematic.

Not all retailer outlets would be able to collect, and store e-waste should a “take back” programme be mandated by legislation. This is due to limited storage space and high floor space rental costs. The introduction of a take back law would however help consumers get rid of e-waste by taking it to retailers who can collect and store items.

The above discussion revealed that convenience to consumers could be ensured if they could take e-waste to their place of work, shopping malls, or to retailers selling electronic and electrical goods. This could help ensure that consumers do not experience e-waste disposal as a nuisance and participate with appropriate initiatives.

The processes required for effective and convenient e-waste disposal include time availability and means to dispose items. Consumers should not have to spend avoidable time and effort to get rid of e-waste, as that will discourage disposal activities. Consumers without access to suitable transportation means, e.g. a pick-up vehicle, to dispose of large e-waste items requires assistance to get rid of these bulky items. An effective e-waste system needs to ensure that the personal convenience factor is addressed when designing a South African system.

In conclusion, the quantitative results proved that personal convenience to consumers is imperative to get them to be willing to participate in e-waste recycling. The qualitative findings revealed that participants across the four stakeholder groups put emphasis on the convenience of mechanisms to co-ordinate and drive the e-waste management processes. To answer RQ3a, a number of suggestions were made on how personal convenience of consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South-Africa.

8.5.2 Integration regarding consumers' attitude towards e-waste recycling and key stakeholders' views on mechanisms

Table 8. 2 shows the joint display addressing research questions RQ3b. The findings depicted and the integration will be discussed in the following sections.

Table 8.2: Joint display of consumers' attitude towards e-waste recycling and key stakeholders' views on e-waste mechanisms

QUANTITATIVE RESULTS		
Construct	Attitude towards e-waste recycling	
Descriptive statistics	M	4.51
	SD	0.52
Correlation with behaviour intention	<i>r</i>	0.473**
	<i>P</i>	<0.001
Contributions towards behaviour intention	<i>P</i>	***
	Estimate	0.226
M=Mean, SD=Standard Deviation.		
. Correlation is significant at the 0.01 level (2-tailed)., *. <i>P</i> <0.001		
QUALITATIVE FINDINGS		
Selected quotations	Participant numbers	Categories
"So, I would say, whilst the households need to take the basic precautions of avoiding any breakage or spillage, okay, it would have to happen on those drop off sites that the municipality runs. It would have to happen on any mass collection points at a shopping mall or something, that you have someone that is actually there typically employed, with the knowledge to separate those streams."	P3ES	E-waste separation stages
"...so, people hang on to stuff because they spent a lot of money on it, and the reality is, that it's worth nothing, it's worth nothing in their hands, but if it goes through a proper system the value can then be unpacked. We're going to try and educate people of the fact that they need to do the responsible thing, I mean for every single individual to try and recycle their own computer or whatever, they're not going to make any money out of it, but a sole separation program needs to be tagged with a different component as well."	P1ES	E-waste reward system to discourage hoarding
INTEGRATION OUTCOME		
Suggestions on how attitude towards e-waste recycling of consumers be can addressed via mechanisms to co-ordinate and drive the e-waste management processes in South-Africa		RQ3b

- ***Quantitative results***

Attitude towards e-waste recycling refers to the consumers' perceptions regarding environmental protection via e-waste recycling (Wang, Guo & Wang, 2016:852). The mean scores for Attitude towards e-waste recycling, indicated in Table 8.2, show that surveyed consumers had an overall positive attitude towards e-waste recycling ($M=4.51$, $SD=0.52$). Furthermore, attitude towards e-waste recycling had a significant correlation with behavioural intention ($p < 0.001$) with a medium, positive correlation between the two factors, $r= 0.473$, as reported for hypothesis 2 (see section 7.10.2 in Chapter 7). The standardised regression weight for attitude towards e-waste recycling is 0.226 ($p < 0.001$), which implies that this factor contributed the second highest towards behaviour intention (see Table 7.60 and Figure 7.9 in Chapter 7).

- ***Qualitative results***

The broad publics' attitude towards environmental protection via e-waste recycling is critical. Interviews with the participants revealed they believe South African consumers are regrettably ill-informed and engage in activities that have potential hazardous environmental effects. Verbatim quotes reflecting the stakeholders' views on consumers' lack of taking precautions to prevent environmental pollution caused by e-waste and some ideas to address this are reflected in Table 8.2.

- ***Integration and conclusion***

It is clear that the following consumer practices to deal with e-waste are problematic and therefore require some modifications:

- Consumer practices to discard e-waste through normal waste bins or bags is problematic due to the serious negative health and environmental consequences.
- The electronic hoarding of used and old electronics by consumers is problematic. Consumers often hoard e-waste items due to sentimental value, an incorrect perception that e-waste has value, for possible later use, and uncertainty about what to do with the items.

Some suggestions to ensure environmental protection via e-waste recycling by consumers could be made:

- A reward system, financially or otherwise, to convince consumers to participate in e-waste recycling and collection process should be considered. This reward system could be in the form of a point rewards where money can be loaded onto a card to be exchanged for product or service. The reward for returning e-waste could persuade consumers to part with items for which they have sentimental value or are too lazy to bring to collection points.
- Knowledgeable persons must be responsible for basic separation at collection points to prevent breakages and spillage.
- Collection and separation must occur formally to ensure that the collected e-waste streams go to recyclers who have been approved to recycle specific streams.

The participants interviewed convincingly argued that e-waste recycling reduces pollution and informal recycling of e-waste is not conducive to effectively deal with the problem. The experts interviewed, as well as the consumers surveyed are positive towards the implementation of a formal e-waste collection and recycling system. The notion of respondents who want to contribute to reduce the harmful effect of e-waste can be achieved if basic separation is done by formally trained personnel at collection points, and approved recycling activities are in place to lower the harmful effect of e-waste. A compensation mechanism to get consumers involved should encourage participation and this view was supported in hypothesis 6, where respondents indicated a willingness to participate in a point rewards system (see Table 7.60 and Figure 7.9 in Chapter 7).

In conclusion, the quantitative results demonstrated that consumer attitudes towards e-waste recycling plays a major role on their environmentally friendly behaviour intentions. In the qualitative findings, the participants discussed some harmful practices of South African consumers. To answer RQ3b, some of the suggestions made to ensure environmental protection via e-waste recycling by consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

8.5.3 Integration regarding consumers' environmental awareness and key stakeholders' views on mechanisms

Table 8.3 illustrates the joint display addressing research question RQ3c. The findings depicted and the integration will be presented in the subsequent sections.

Table 8.3: Joint display of consumers' environmental awareness and key stakeholders' views on mechanisms

QUANTITATIVE RESULTS		
Construct	Environmental awareness	
Descriptive statistics	M	4.61
	SD	0.56
Correlation with behaviour intention	<i>r</i>	0.468**
	<i>P</i>	<0.001
Contributions towards behaviour intention	<i>P</i>	***
	Estimate	0.191
M=Mean, SD=Standard Deviation.		
. Correlation is significant at the 0.01 level (2-tailed), *, <i>P</i> <0.001		
QUALITATIVE FINDINGS		
Selected quotations	Participant numbers	Categories
"...technically electronic waste is classified as hazardous waste, and so the responsibility of the consumer is not to actually dispose of it as general waste, but often what happens is, the consumer doesn't know,... and secondly they don't know where to drop it off, they don't understand the details and intricacies of e-waste disposal. ...I also think that it is the producer's responsibility to make people aware of the fact that their product has the potential to damage the environment and that it should be handled with care"	P4ES	Creating legislation and awareness on e-waste
"I think everybody should be involved, from top tier government, right down to your manufacturers, your OEM's, your importers, your exporters, it all starts at the top, but preferably your sellers and your re-sellers should be made well aware of what the hazards are of electronic waste, as well as to educate the clients and say to them, this is what I'm selling to you, do note that you need to have a responsible recycler to take care of your electronic waste for you."	P14RDE	Responsible parties for e-waste management
INTEGRATION OUTCOME		
Suggestions on how environmental awareness of consumers can be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South-Africa		RQ3c

- ***Quantitative results***

Environmental awareness refers to consumers' support or active work towards the protection of the natural environment from destruction or pollution (American Heritage Dictionary, 2011). The mean scores for environmental awareness, as indicated in Table 8.3, show that overall consumers had a positive level of environmental awareness ($M=4.61$, $SD=0.56$). Furthermore, environmental awareness had a significant correlation with behavioural intent ($p < 0.001$), with a medium, positive correlation between the two factors, $r = 0.468$ as reported for hypothesis 1 (see section 7.10.5 in Chapter 7). Based on the standardised regression weight for environmental awareness of 0.191 ($p < 0.001$), it was concluded that this factor was third highest contributor towards behaviour intention (see Table 7.60 and Figure 7.9 in Chapter 7).

- ***Qualitative results***

The importance of environmental awareness of all South Africans to implement successful e-waste management processes in South Africa was emphasised during the interviews with participants in the qualitative phase. Verbatim quotes reflecting the stakeholders' views on the lack of concern and knowledge regarding environmental pollution of consumers, and suggestions to improve environmental awareness are included in Table 8.3.

- ***Integration and conclusion***

The following consumer practices to deal with e-waste are not ideal and suggest that environmental awareness are often not aligned with behaviour. Some modifications are therefore required.

- Consumers are often not aware of the hazardous nature of e-waste, and that is the major reason why batteries, CFL bulbs, and CRT screens end up in landfills through the municipal collection system. Toxic elements such as mercury, lithium, and lead are a few substances that are disposed of into nature as a result.
- Consumers allowing e-waste to end up with informal recyclers who typically smash and burn the items to get hold of the valuable materials. The negative result of toxic fumes are not anticipated by consumers lacking knowledge.

Some suggestions to ensure environmental protection via e-waste recycling by consumers are as follow:

- Dedicated e-waste legislation must be drafted by Government after all stakeholders involved in the process have been consulted. This will give direction to all parties involved.
- Education through the media is needed to make consumers aware of the hazardous nature of e-waste.
- Retailer involvement is imperative to get consumers involved from an early stage.

Participants indicated that EPR, as an international management tool, was the way forward to solve the South African e-waste problem. The proposal is for a PRO to be the responsible party to set up and run an EPR system as the South African government does not have the capabilities or know how to implement or run such a system. The PRO need to bring the producers, retailers, recyclers, refurbishers, and especially consumers together to solve the e-waste problem. By implementing such a system, the daily habits of consumers could be changed to have a positive effect on their disposal habits, as they will be educated to act responsibly. E-waste education is urgently required to inform consumers about the hazardous nature of e-waste, which will strengthen the view of consumers to recycle and avoid informal recycling, thus protecting natural resources.

In conclusion, the quantitative results demonstrated that consumers' environmental awareness plays a major role in positive behaviour intentions. In the qualitative findings, the participants discussed some harmful practices of South African consumers. To answer RQ3c, suggestions were made to ensure environmental protection via e-waste recycling by consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

8.6 CONCLUSION

This chapter has presented the integration phase of this empirical study. The chapter began with a presentation on the integration of the qualitative and quantitative phases of the current mixed methods research study.

The research objective and questions of the integration phase and the integration levels and purpose were presented. Finally, the convergent design joint displays and answers to the three research questions of the integration phase of the study were presented.

The final chapter deals with conclusions and recommendations for future studies and summarises the findings of the preceding chapters.

CHAPTER 9: DISCUSSION AND CONCLUSIONS

9.1 INTRODUCTION

This chapter presents a summary of the research findings obtained from this mixed methods study. It firstly presents the aim, objectives and structure of the study. Secondly, a summary and discussion of the qualitative research phase findings, quantitative research phase results and the integration research phase are presented. Thirdly, the chapter proposes a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. Fourthly, the chapter discusses the study's main contribution. Finally, limitations and recommended areas for future study are presented.

9.2 AIM, OBJECTIVES AND STRUCTURE OF THE STUDY

9.2.1 Research aim and objectives

The aim of this study was as follows:

- To propose a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa.

The research objectives of each of the three phases are presented below:

- ***Qualitative phase***

Research objective 1:

To explore the current practices and views of key stakeholders on the re-use, recycling and disposal of waste electrical and electronic equipment in South- Africa.

To meet research objective 1, related to the qualitative phase, the following three research questions were answered:

Research questions:

- RQ1a: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste collection from household consumers?
- RQ1b: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste distribution to recyclers?
- RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

- **Quantitative phase**

Research objective 2:

To examine the drivers and inhibitors of e-waste recycling behaviour intentions of South African household e-waste consumers.

In order to meet research objective 2, related to the quantitative phase, the following nine hypotheses were tested:

Hypotheses:

- H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.
- H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.
- H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.
- H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.
- H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.
- H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.
- H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.

- H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.
- H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.

- ***Integration phase:***

Research objective 3:

To advise how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results), should be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa (qualitative results).

To meet research objective 3, related to the integration phase, the following three research questions were answered:

Research questions:

- RQ3a: How can personal convenience of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?
- RQ3b: How can attitude towards e-waste recycling of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?
- RQ3c: How can environmental awareness of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

9.2.2 Structure of the study

Chapter 1: Introductory Chapter

Chapter 1 introduced the study. It offered an introduction to the background, the research problem, research aim, and objectives of the study. This was followed by an explanation of the research design and methodology as guided by an illustrative framework. The contribution and delimitations of the study were then considered, thereafter the key terms, abbreviations and acronyms were presented.

Chapter 2: A Global Perspective on E-Waste Management

In Chapter 2, e-waste was defined and the valuable but toxic nature of e-waste was highlighted. The mechanisms to co-ordinate and drive the e-waste management processes around the globe were discussed. These mechanisms included EPR and PS, legislation, collection arrangements, and financing models.

Chapter 3: A South African Perspective on E-Waste Management

A materials flow diagram from a previous study was introduced, as the scenario has not changed. Key mechanisms to co-ordinate and drive global e-waste management were used to review the South African e-waste environment. A theoretical framework of sustainable waste management and a conceptual model for municipal solid waste management were analysed and several shortcomings were identified. A conceptual framework was developed, which would guide the present research process.

Chapter 4: Green Marketing, a Way to Green Economy and the Theory of Planned Behaviour (TPB)

In Chapter 4, the Green marketing concept was introduced and the position of e-waste in the green marketing sector was highlighted. The TPB was applied to consumer studies and used to develop a model for the South African household scenario. The TPB model has been used in previous e-waste studies and hypotheses were developed for the South African study. A model based on the TPB model was developed and tested.

Chapter 5: Research Design and Methods

Chapter 5 described the aim and objectives of the study and the rationale for conducting a convergent parallel mixed methods research study. The qualitative phase, including the research orientation, paradigm, and design were discussed. This was followed by an explanation of the participant selection, data collection, and data analysis and reporting. The qualitative phase concluded with a section on quality and ethical considerations. The quantitative phase, including the research paradigm and design were discussed. This was followed by the sample design data collection, data preparation and the analysis methods employed in the quantitative phase. The quantitative phase concluded with a section on the model measurement. The chapter concluded with a short description on how the integration of the two phases would be done.

Chapter 6: Qualitative Findings and Discussion

In Chapter 6, the qualitative findings were discussed. A background of the researcher co-coder, co-supervisor were given, as well as that of the participants. Research question 1a, 1b, and 1c, were presented together with the related themes, categories and codes. Rich participant quotations were used in the discussions and suggestions related to each category were made.

Chapter 7: Results of the Quantitative research phase

In Chapter 7, the results of the survey were discussed. The response rates, demographic profiles, descriptive statistics, factor analysis, and the effect of biographical variables on the factors were analysed. Structural equation modelling was used to test unique contributions towards behaviour intentions of consumers, followed by hypotheses testing.

Chapter 8: Integration findings and discussion

In Chapter 8 the findings of Chapters 6 and 7 were united to establish how the main contributors to e-waste recycling behaviour intentions of consumers (quantitative results) should be addressed via the mechanisms to co-ordinate and drive the e-waste management processes in South-Africa (qualitative results). Advice was given to help alter negative consumer disposal practices and assist them in how e-waste is perceived.

9.3 SUMMARY AND DISCUSSION OF THE QUALITATIVE RESEARCH PHASE FINDINGS

9.3.1 Research study participants

Twenty purposively selected participants from four key sectors in the e-waste scenario in South Africa were interviewed. Four of them represented environmental specialists, nine represented government authorities, five represented recycling/disposal entities and two participants represented supply chain members.

9.3.2 Conclusions regarding RQ1a: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste collection from household consumers?

To answer this question, the experiences and views of key stakeholders involved in e-waste collection from household consumers were analysed. It was concluded that kerbside placement should not be allowed and proposals to collect LDA's were made. The importance of the convenience factor to dispose e-waste was emphasised as the key to effective e-waste collection. Suggestions for collection points at rural areas, retailers, shopping malls, garden refuse sites and mobile collection initiatives were offered.

The limited role local government should play was underlined and suggestions for rural area collections were presented. The importance of keeping e-waste separate from household waste, as well as doing basic separation at collection points was also emphasised.

9.3.3 Conclusions regarding RQ1b: What are the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment on e-waste distribution to recyclers?

To answer this question, the experiences and views of key stakeholders involved in transportation of household e-waste were analysed. The problematic legislation and proposals for new legislation were discussed. The importance of coordinated transport collections to ensure efficiency was emphasised. Discussions on parties responsible for transport costs for e-waste were also presented.

9.3.4 Conclusions regarding RQ1c: What are the views of key stakeholders involved in the life cycle of electrical and electronic equipment on alternative mechanisms to develop a sustainable e-waste management system in South Africa?

To answer this final qualitative research question, the experiences and views of key stakeholders on alternative mechanisms to develop a sustainable e-waste management system for household e-waste in South Africa were analysed. The following aspects could contribute to alternative mechanisms to develop a sustainable e-waste management system in South Africa.

- ***Extended Producer Responsibility (EPR)***

Participants indicated a preference for EPR to address household e-waste. The intersecting roles of the different stakeholders, as well as an urgent need for legislation to implement EPR were highlighted. The importance of consumer education regarding e-waste was also emphasised. To ensure a sustainable system, funding of the EPR programme is essential.

- ***Addressing problem areas regarding recycling infrastructure in South Africa and defining the role of government in addressing the recycling needs***

The preferred method of collection and the views on the visibility of the fee were discussed. Serious shortcomings in some recycling facilities, as well as the need for refurbishing centres, were revealed and the role of the government to address the situation were analysed. Government should play an initiator role while producers should fund the whole process through a recycling fee. The recycling fee will be levied on imported or manufactured items and used to manage the whole process, fund transport activities and a rewards system, ultimately ensuring the recycling and disposal are done according to legislative requirements.

- ***Producer Responsibility Organisation (PRO)***

The mistrust in the government, corruption, and their historical inability to address recycling needs must be addressed. There is therefore an urgent need for a transparent system managed by an independent e-waste PRO. Suggestions of the preferred PRO format, as well as who should be involved in the PRO board, were given and discussed. The importance of an independent operational section of the PRO, who has no industry links, was communicated as non-negotiable by participants.

- ***Take back scheme and reward system***

To ensure the involvement of all stakeholders, a registry was suggested to curb free riders. Consumers, as the legal owners of e-waste, should be encouraged to separate their e-waste from household waste to prevent pollution if it ends up on landfills. Consumer rewards programme to initiate the process was proposed, especially for rural areas. The important role of the retailer section as a take-back point, information centre, and the challenges faced by them were highlighted.

- ***Proposed auction house***

Although some participants were against the idea of an auction house, the majority were in favour of the concept, as many aspects of what is needed to manage the e-waste system effectively could be addressed. This would include the arrangement of transport to collection points, collection of LDA's, separation into refurbishing and other streams, the distribution to recycling facilities, and an auditable system from which government could receive numbers of recyclable fractions.

The qualitative research question thus received detailed answers and suggestions from participants, which, if implemented, would contribute immensely to the development of an effective management model for South African household e-waste.

9.4 SUMMARY AND DISCUSSION OF THE QUANTITATIVE RESEARCH PHASE RESULTS

9.4.1 Demographic profile of respondents

There was a relatively equal distribution between males (52.9%) and females (46.4%), while 0.8% did not indicate their gender. The majority of respondents were 50 years or older (52.5%). The majority of the respondents (84.5%) lived in urban areas; 72.4% in metropolitan cities and 12.1% in mid-sized towns.

The income of the respondents was distributed in a Bell curve, with the exception of 20.7% of the 522 respondents who earned more than R 76 801 per month. The majority (83.4%) of the 522 respondents had some form of post-school qualification. The majority (47.7%) of the 522 respondents spoke English as their home language, 36.2% spoke Afrikaans, 15.3% spoke an African language, whilst 0.8% did not indicate their home language.

9.4.2 Hypothesis testing from the conceptual model for the South African e-waste scenario

The research hypotheses tested in this phase were based on the TPB and past studies, as discussed in Chapter 4. The following discussion is grounded on the results of hypotheses testing.

- ***H1: There is a significant positive relationship between consumers' environmental awareness and e-waste recycling behaviour intentions.***

Based on the results, the hypothesis H1 was supported. This is in line with previous studies on the behavioural intentions of millennials in India (Chaudhary & Bisai, 2018:804), e-waste recycling practices in Beijing City, China (Wang, Guo & Wang, 2016:855) and battery pack recycling intentions in Belgium (Lizin *et al.* 2017:76).

Thus, increasing environmental awareness can be used to improve e-waste recycling behaviour of consumers.

- ***H2: There is a significant positive relationship between consumers' attitude towards e-waste recycling and e-waste recycling behaviour intentions.***

Based on the results, hypothesis H2 was supported. This corroborates with studies on recycling behaviours in developed countries (Hansmann *et al.*, 2006:133; Nixon & Saphores, 2007:557; Tonglet *et al.*, 2004:191), and in developing countries such as Brazil (Echegaray & Hansstein, 2017:186) and Vietnam (Nguyen *et al.*, 2018:3). Thus, increasing the positive attitude towards e-waste recycling can be used to improve e-waste recycling behaviour of consumers.

- ***H3: There is a significant negative relationship between consumers' views on norms and publicity and e-waste recycling behaviour intentions.***

Based on the results, hypothesis H3 was supported. This result is in agreement with other studies that could also not find any positive association between norms and behaviour intentions (Milovantseva & Saphores, 2013:14; Paul *et al.*, 2016:123; Zhong & Huang, 2016:478). It is however in conflict with studies reporting on the positive relation between norms and e-waste recycling behaviour intention (Chaudhary & Bisa, 2018:798; Lizin *et al.*; 2017:76; Nguyen *et al.* 2018:3; Saphores, 2007:20). From the different findings it is evident that some countries put efforts into legislation and media publication while others ignore this important measures. Norms and publicity refers to perceptions of consumers regarding laws, relevant and enough media information, peer pressure to dispose of e-waste. Personal experience from the researcher was confirmed when urban South African consumers clearly demonstrated that they do not experience a drive from peers, the media and legislation. In order to have a positive relationship between norms and publicity and e-waste recycling behaviour intentions the dangers and negative impact of

irresponsible recycling needs to be addressed through legislation and the media. Peer pressure will follow as a result. This finding thus suggests that norms and publicity are a suitable or likely way to influence e-waste recycling behaviour intentions.

- ***H4: There is a significant negative relationship between consumers' perceived cost of recycling and e-waste recycling behaviour intentions.***

Based on the results, the hypothesis H4 was supported. This is in line with previous studies findings that the costs of recycling inhibits recycling behaviour intentions to e-waste (Colesca, Ciocoiu & Popescu, 2014:363; Wang *et al.*, 2017:301). Thus, decreasing the perceived cost of recycling can be used to improve e-waste recycling.

- ***H5: There is a significant negative relationship between consumers' view on convenience of recycling and e-waste recycling behaviour intentions.***

It must firstly be noted that the study amongst urban South African consumers revealed that convenience of recycling is perceived as two separate entities, one being personal convenience and the other convenience of facilities. In Table 7.11 the questions used in the construct were highlighted and the descriptive statistics were shown. In Table 7.16 it was shown that the construct divided into two separate dimensions, one related to personal convenience, and the other to convenience of facilities. A full analysis of this phenomena was given in section 7.5, subsection "Convenience of recycling". In Table 7.59 and Figure 7.9 it was shown that personal convenience was the highest unique contributor towards behaviour intention. Based on the results, specifically "personal convenience", hypothesis H5 was supported. There is agreement with other studies conducted mainly in developing countries that also could not find any positive association between convenience and behaviour intentions (Bendak & Attili, 2017:7; Colesca *et al.*, 2014:363; Echegaray & Hansstein, 2017:186; Saritha *et al.*, 2015:36; Ylä-mella *et al.*, 2015:374; Zhong & Huang, 2016:478). In developed regions, such as Italy and California (USA), the result is opposite as a positive relation was found between convenience and e-waste recycling behaviour intention (Favot & Grassetti, 2017:229; Saphores *et al.*, 2006:200). Personal convenience proved to be the biggest contributor to behaviour intention to recycle e-waste amongst respondents, while convenience of facilities had a non-significant correlation with behavioural intent. Consequently, increasing personal convenience can be used to improve e-waste recycling.

- **H6: There is a significant positive relationship between consumers' willingness to participate in a PRS and e-waste recycling behaviour intentions.**

Based on the results, the hypothesis H6 was supported. This is in line with previous studies, which found a positive association between being rewarded and green behaviour intentions (Borthakur & Govind, 2018:1065; Geller, 2002:94; Zhong & Huang, 2016:477). Thus, increasing participation in a point rewards system can be potentially used to improve e-waste recycling.

- **H7: There is a significant positive relationship between consumers' willingness to pay a recycling fee and e-waste recycling behaviour intentions.**

Based on the results, the hypothesis H7 was supported. The result from this study is in agreement with some studies that also found a positive association between willingness to pay a recycling fee and behaviour intentions (Nixon & Saphores, 2007:557; Saritha, Sunil Kumar & Srikanth, 2015:38; Song, Wang & Li, 2012:14). However this finding is in conflict with other studies reporting a negative relation between willingness to pay a recycling fee and e-waste recycling behaviour intention (Afroz *et al.*, 2013:1; Islam, *et al.*, 2016:737; Yin, Gao & Xu, 2014:517). This discrepancy could be rooted in economic differences, cultural differences, attitude towards recycling, lack of knowledge, etc. In other previous studies, including the current study, consumers are generally willing to pay a reasonable recycling fee (less than 10% of the selling price). The study done by Nixon & Saphores (2007:557) was done in California (USA) while the rest of the studies were done in third world countries. It is encouraging to experience urban consumers displaying a willingness to pay a recycling fee. Based on the outcome of hypothesis 6 the same consumers would also prefer some payback in the form of point rewards if e-waste is returned. As a third world country this reaction was to be expected. The positive feedback on point rewards and a willingness to pay a recycling fee must be used to encourage urban consumer participation in an e-waste return program.

- ***H8: There is a significant negative relationship between consumers' income and e-waste recycling behaviour intentions.***

Based on the results, hypothesis H8 was not supported. The result from this study is in disagreement with some studies that found a positive association between income and behaviour intentions (Milovantseva & Saphores, 2013:15; Nguyen *et al.*, 2018:3), however it is also in conflict with other studies reporting a negative relation between income and e-waste recycling behaviour intention (Echegaray & Hansstein, 2017:185; Wang *et al.*, 2016:855-856). Thus, efforts to improve e-waste recycling does not need to focus specifically on any income sector.

- ***H9: There is a significant relationship between consumers' demographical variables (a Gender, b Age, and c Education) and e-waste recycling behaviour intentions.***

Based on the results, the hypotheses were partially supported as only age had a significant positive correlation with behavioural intention. The result from this study is in agreement with some studies that found a positive association between age and behaviour intentions (Borthakur & Govind, 2018:1065; Nixon & Saphores, 2007:557), however it is in conflict with other studies reporting a negative relation between age and e-waste recycling behaviour intention (Colesca, Ciocoiu & Popescu, 2014:361-362; Echegaray & Hansstein, 2017:4; Zhong & Huang, 2016:479). Thus, efforts to improve e-waste recycling does not need to focus specifically on gender or educational differences. There should however be a focus to increase the participation of younger consumers to improve e-waste recycling.

9.5 SUMMARY AND DISCUSSION OF THE INTEGRATION RESEARCH PHASE

In the integration phase, the three largest contributing factors to behaviour intention were analysed and current limiting practices were highlighted. Suggestions were made on how to reduce or limit scenarios not conducive to e-waste recycling and collection.

9.5.1 Conclusions regarding RQ3a:

How can personal convenience of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

To answer this question, the views of the participants and the personal convenience factor as required by respondents were analysed and proposals of convenient collection methods and sites were given. These included taking e-waste to their place of work, shopping malls, retailers, or on arranged collection days where the site, day and time are properly communicated. A proposal was given to introduce a technological driven “Call-to-collect” system to dispose large e-waste items in urban areas. Numerous suggestions were made as to how personal convenience of consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

9.5.2 Conclusions regarding RQ3b:

How can attitude towards e-waste recycling of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

To answer this question, the views of the participants and consumers’ attitude towards e-waste recycling were analysed and proposals to address the attitudes were given. It was suggested that consumers must separate e-waste at home to ensure it does not end up with the normal household garbage. At collection points, further ‘basic’ separation must be done by formally trained personnel. Approved recycling activities must be in place to lower the harmful effect of e-waste. A compensation mechanism was suggested to encourage consumer participation. Suggestions were made to ensure environmental protection via e-waste recycling by consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

9.5.3 Conclusions regarding RQ3c:

How can environmental awareness of consumers be addressed via mechanisms to co-ordinate and drive the e-waste management processes in South Africa?

To answer this question, the views of the participants and consumers’ environmental awareness were analysed and proposals to address the environmental awareness of e-waste recycling were given. The proposal was that EPR, as an international management tool, was the way forward to solve the South African e-waste problem. A further proposal was for a PRO to be the responsible party to set up and run an EPR system.

The PRO will bring the producers, retailers, recyclers, refurbishers, and especially consumers together to solve the e-waste problem. The daily habits of consumers could be changed and have a positive effect on their disposal habits, as they would be educated to act responsibly towards the environment. E-waste education is urgently required to inform consumers about the hazardous nature of e-waste, which will strengthen the view of consumers to recycle and avoid informal recycling, thus protecting natural resources. Some suggestions were made to ensure environmental protection via e-waste recycling by consumers could be addressed in mechanisms to co-ordinate and drive the e-waste management processes in South Africa.

9.6 A FRAMEWORK FOR THE RE-USE, RECYCLING AND DISPOSAL OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT IN SOUTH AFRICA

Figure 9.1 depicts the framework for the management of e-waste in South Africa. The discussion will follow a structure focusing on the collection, transportation, and mechanisms to develop a sustainable e-waste management system. To guide the discussions, the vertical axis on the framework was labelled from A to F, and the horizontal axis was numbered from 1 to 8. Zone A-1 for example refers to the top left corner of Figure 9.1.

9.6.1 PHASE 1: E-waste collection from household consumers

The handover of e-waste from consumer into the recycling stream is paramount as this is the first step towards effective disposal. The better the collection efforts, the more viable a recycling system becomes. The quantitative research phase indicated that personal convenience to consumers was the biggest contributor to ensure e-waste is correctly disposed by them. This was integrated with the qualitative phase to propose some options to assist and ensure that e-waste collection from consumers was effective and convenient. These alternatives to make the disposal activities convenient for consumers, as incorporated in Figure 9.1 zone D, E, and F-4, include the following:

- *Call-to-collect.* The introduction of a web-based system where consumers can arrange a collection using a cell phone application, connect to a website, or call to arrange for the collection of large appliances would be ideal. The convenience factor could be

- addressed as large appliance collections could be arranged with minimal effort by consumers (Refer to discussions in section 6.5.1 in Chapter 6, and 8.5.1 in Chapter 8).
- *Corporate collection points* refers to collection points that are set up at companies/entities with large enough employee numbers to make collections viable. Consumers can then take small e-waste items to their place of work and this option should be introduced and expanded. This implies that consumers do not have to make additional trips to dispose of e-waste, which should make this a convenient alternative (Refer to discussions in section 6.5.2 in Chapter 6 and 8.5.1 in Chapter 8).
 - *Shopping malls should be incorporated* as collection points for e-waste as consumers normally go to the malls for shopping or leisure activities. Receptacles should be placed inside shopping centres to collect small e-waste items, such as batteries, CFL bulbs, and printer cartridges. Where space allows, shipping containers should be placed in the parking area and manned by knowledgeable collection staff working for the PRO. Basic separation could be done by the personnel to avoid breakage. The e-waste collection staff would act as a security measure, preventing informal recyclers from pestering consumers to get hold of e-waste. Larger e-waste items, such as toasters, televisions, kettles, and microwave ovens can be disposed at these containers. Consumers would thus not have to make additional trips to dispose e-waste, and disposal would be safe and secure, all contributing to a convenience factor (Refer to discussions in section 6.5.2 in Chapter 6 and 8.5.1 in Chapter 8).
 - *Retailers* as collection points refers to places where consumers bought their electrical and electronic equipment. As consumers would be familiar with these places, they are likely to adapt to the idea that the items can be returned to the same or similar place. Retailers should be legally bound to accept similar types of e-waste being sold in their stores. As consumers are familiar with these outlets, returning e-waste items to this site could be a convenient alternative (Refer to discussions in section 6.7.1 and 6.10.2 in Chapter 6 and 8.5.1 in Chapter 8).
 - *Transfer sites*, such as garden refuse sites, could be upgraded to include collection points for hazardous materials. This offers convenience to consumers as these sites are normally in close proximity to residential areas where residents regularly dispose garden refuse (Refer to discussions in section 6.5.2 in Chapter 6 and 8.5.1 in Chapter 8).

- *Collection days* can be arranged at specific sites and at regular time intervals, such as the first Saturday of every month. Consumers would get used to the arrangement and use this opportunity, as weekends are an alternative to consumers who do not have flexibility during the week. Consumers should take e-waste items to the collection day initiatives if this arrangement was permanently implemented. Another advantage of this collection arrangement is that basic separation would be done on receipt of the e-waste. (Refer to discussions in section 6.5.3 in Chapter 6 and 8.5.1 in Chapter 8).

9.6.2 PHASE 2: E-waste distribution to recyclers

Zones D, E, and F- 6/7 in Figure 9.1 depict the discussion of e-waste distribution to recyclers. E-waste must be collected at the collection sites, while transportation trips must be kept to a minimum due to transport being a high cost factor (Refer to section 6.5.5 of Chapter 6). To ensure economy of scale, the transportation arrangements must be centralised at the PRO from where co-ordinated collection arrangements would be done (see “Transport Administration” in zone B-4 in Figure 9.1).

In section 6.11.1 of Chapter 6, the use of an auction house was proposed. A separation station could however serve the same purpose. The auction house/separation station (Zone F-5/6 in Figure 9.1) is needed to ensure that e-waste streams are separated into streams that could be accommodated by either approved refurbishers or recyclers. This arrangement, where e-waste is transported to central auction houses or separation stations would ensure that collection in rural and smaller towns was done efficiently (Refer to discussions in section 6.11.1 of Chapter 6).

Through single transport trips, all types of e-waste can be collected from any collection point, including rural areas and small towns. The separation would occur at the auction house/separation station and be distributed to the correct refurbisher or recycler. The auction house or separation station need to keep detailed records of the items and weights that entered the waste stream. The recycler or refurbisher (Zone D, E, and F-6/7 in Figure 9.1) must account for exports, local scrap metal dealers, and hazardous waste disposal weights to the PRO (See dotted lines going from separation station and recyclers/refurbishers to “Weights/Items capturing”-Zone B-5 in Figure 9.1).

The refurbisher or recycler must transport the e-waste from the auction house/separation to the recycling facility. The assumption here is that recyclers or refurbishers are profitable. Where recycling facilities do not exist, e.g. cooling equipment, recycling plants must be developed (Zone F-6/7 in Figure 9.1). The business model must be such that transport arrangements will also be done by the recycler.

9.6.3 PHASE 3: Alternative mechanisms to develop a sustainable e-waste management system in South Africa

- ***Producer responsibility organisation (PRO)***

Zones A and B-2 to 7 in Figure 9.1 depict the discussion related to the PRO. The findings of this research suggested that a single PRO should be responsible for managing the urban household e-waste scenario (refer to discussions in section 6.7.4 of Chapter 6). The management should be done using EPR principles, which are executed by means of informative, administrative and economic instruments (refer to discussions in section 6.7 of Chapter 6).

To implement EPR principles the following departments should be incorporated into a PRO:

- *Finance* (Zone B-2 in Figure 9.1): The PRO should function financially independent from the South African Government. Government corruption, a failure to recognise the environmental impact of e-waste, and political agendas with recycling funds, have been experienced in the past with the plastic bag and REDISA recycling funds (refer to discussions in section 6.7.1 of Chapter 6). The PRO should be in charge of receiving the recycling fee from producers to ensure it is allocated to e-waste recycling initiatives only and not for political or personal use (refer to discussions in section 6.7.3 of Chapter 6).
- *Transport administration* (Zone B-4 in Figure 9.1): Transport arrangements from collection points and rural areas must be co-ordinated from the transport section of the PRO to ensure economy of scale. Transport is one of the main cost components and should be limited, especially when long distances must be travelled to collect rural or countryside e-waste (refer to discussions in section 6.5.5 and 6.11.1 of Chapter 6).

- *Weight/items capturing* (Zone B-5 in Figure 9.1): The PRO must act as the central hub for capturing weights of fractions going into the waste stream. This will allow accurate reporting on recycling figures entering the auction house/separation station. Detailed figures of waste going to recyclers can be captured, while the recyclers and refurbisher would be in a position to report to this department on refurbished or recycled figures. This department would consequently be in a position to ensure that weights entering the waste stream are accounted for. The PRO would be in a position, through the weight/item-capturing department, to report yearly to Government as an overseeing body (refer to discussions in section 6.9.1 of Chapter 6).
- *Compliance* (Zone B-6 in Figure 9.1): A department in the PRO must ensure there is compliance from all sectors of the e-waste industry, especially the recycling sector. With suitable legislation being in place, this department must ensure that all stakeholders comply with the requirements. They should have punitive powers to ensure that stakeholders stay within the legislative boundaries, thus steering the system to stay on track (refer to discussions in section 6.7.4 and 6.9.1 of Chapter 6).
- *Register administration* (Zone B-7 in Figure 9.1): A department in the PRO should be responsible for initiating and the upkeep of a registry. Importers, local manufacturers, recyclers, and refurbishers would be responsible for communicating with the PRO on essential issues (e.g. export figures, weight of fractions, and refurbished items). This registry would limit free riders in the system, who receive benefits from sales but are reluctant to contribute to ensure that the system is financially sustainable. The registry would be able to link the different sectors in the electrical/electronic industry and help identify areas where unsafe and illegal practices occur (refer to discussions in section 6.9.1 in Chapter 6).
- *Management body* (Zone A-2 to 7 in Figure 9.1): The management should involve representatives from producers, retailers, recyclers, public representative bodies, Government representatives, and environmentalists. Each of these mentioned sectors are involved to some degree in the e-waste sector and need to be represented to ensure the system functions effectively. One sector should not be exploited while others thrive. Dialogue and consensus should ensure that the system is steered towards success. The involvement of all these parties should ensure a corruption free system where there is accountability and transparency to the public, who is ultimately going to pay for the recycling, and pay the price if recycling is not prioritised. It is imperative that there should be a separation of direct involvement from

the PRO board and the implementing body of the PRO. The day-to-day operations must be done by the implementing body without any links between operational personnel and industry stakeholders to prevent corruption (refer to discussions in sections 6.7.1 and 6.9.1 of Chapter 6).

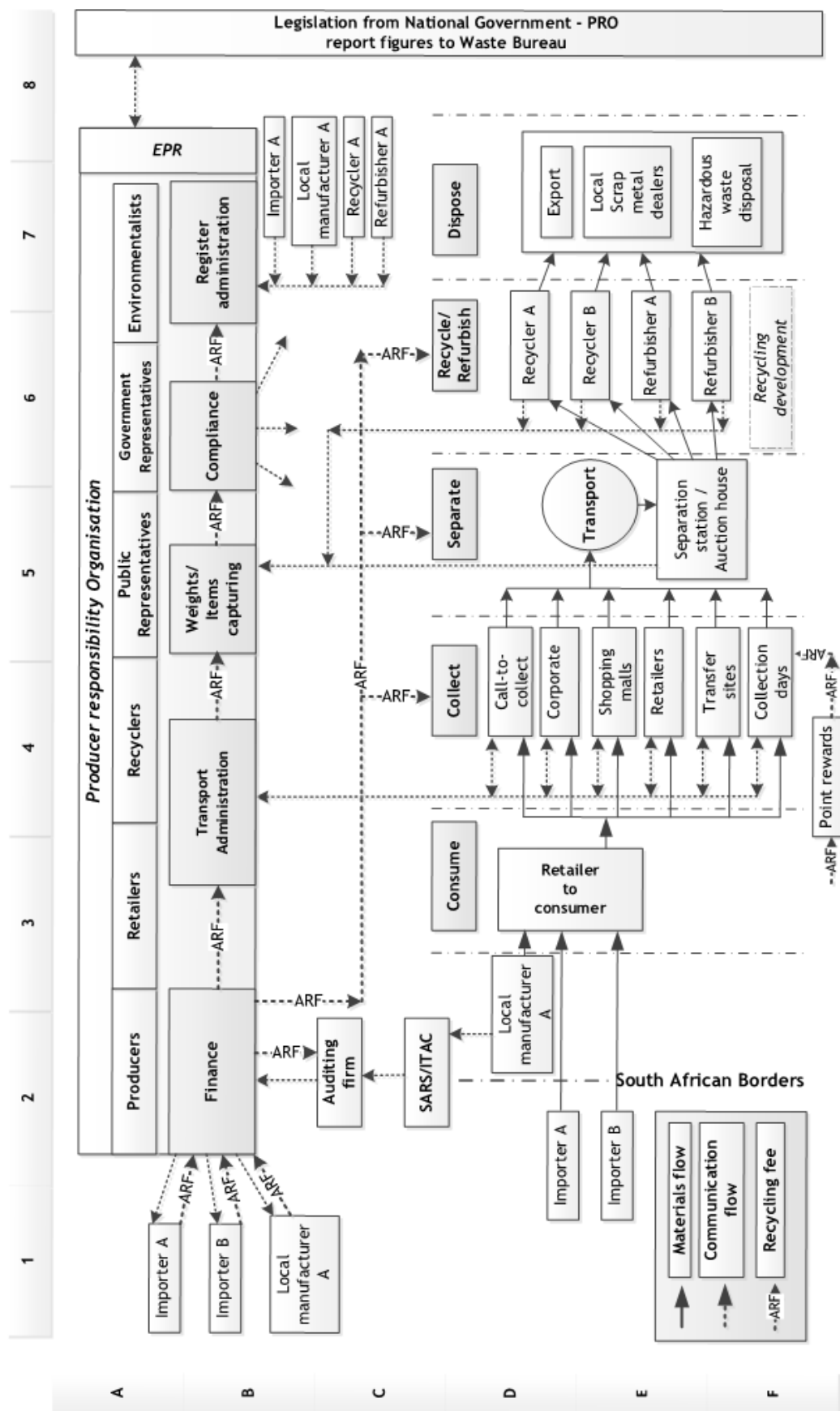
- ***Advanced recycling fee (ARF)***

This research revealed that the successful management of a South African e-waste system depends on a recycling fee being charged. The South African Government's involvement in the recycling fee collection must be limited to SARS and the International Trader Advisory Commission (ITAC), who should jointly supply import and manufactured figures to an auditing firm (See Zone C and D-2 in Figure 9.1). SARS and ITAC capture import numbers of everything entering the borders of South Africa, including all electrical and electronic items. Local manufacturers, of which there are few, must report manufacturing figures to SARS (Zone D-2/3 in Figure 9.1). Importers and local manufacturers (see zone D-2 in Figure 9.1) are thus known to these two entities and with the involvement of an auditing firm, numbers and weights of imported items can be consolidated. The exact recycling fee owed by the respective importers can thus be determined by the auditing firm and collected from the importers and local manufacturers (see zone A and B-1 in Figure 9.1) by the finance department of the PRO (Zone B-2 in Figure 9.1) (refer to discussions in sections 6.7.3 and 6.9.1 of Chapter 6). The recycling fee should cover the operational costs of the PRO as well as transport costs of collections to the auction house/separation station. This would include call-to-collect transportation as well as transport to and from collection points to the auction house/separation station. The recycling fee should also cover the development costs of recycling facilities, which does not exist at present, e.g. cooling equipment recycling (Zone F-6/7 in Figure 9.1) (refer to discussions in sections 6.7.3 of Chapter 6). The point reward system (see Zone F-4 in Figure 9.1) to initiate the system should also be funded from this recycling fee (refer to discussions in sections 6.10.1 in Chapter 6). Negative value items refer to items where the expenses to recycle items is higher than the income that can be generated. Businesses will not get involved if there are no financial benefits, resulting in the ARF fee having to cover the setup costs, transport costs, disposal fees, and all other running expenses (refer to discussions in section 6.6.1 of Chapter 6).

- ***Government involvement***

In section 6.8.2 of Chapter 6, the role of Government in the e-waste recycling process has been discussed. Government should involve all stakeholders from where e-waste legislation must be drafted for final approval. The PRO will consequently function as the implementing body communicating with Government regarding e-waste figures, progress, and new facilities being set up to cater for all e-waste items (see Zone A to F-8 in Figure 9.1). Government will therefore play the role of an overseeing body, while the PRO will be the implementing body, managing the whole system from import to final disposal.

Figure 9.1: A framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa



9.7 CONTRIBUTION OF THE STUDY

9.7.1 Methodological contribution

In the qualitative phase, a detailed and accurate account was given of how the research was designed and implemented. The data collection and data analysis processes were also discussed in depth. This can guide researchers considering further exploratory research on this topic.

For the quantitative phase, specific scales were included in the measurement instrument (Environmental awareness; attitude towards e-waste recycling; norms and publicity; cost of recycling; convenience of recycling; behavioural intention) that were adopted for previous studies (Wang, Guo & Wang, 2016:859; Zhong & Huang, 2016:479). The instrument could thus be applied to validate and extend the TPB to other recycling and green marketing behaviours of consumers.

The key methodological contribution of the current study is that it is one of the first mixed method studies to offer an integrated summary of the determinants and inhibitors of e-waste behaviour intentions (quantitative research), and views (qualitative research) of e-waste management by stakeholders.

9.7.2 Theoretical contribution

WEEE management systems and practices have been examined in various industrialised countries (Bahers & Kim, 2018; Dias, Bernardes & Huda, 2018; Duygan & Meylan, 2015; Morris & Metternicht, 2016; Parajuly, Habib & Liu, 2017; Ylä-Mella *et al.*, 2014; Zacho, Bundgaard & Mosgaard, 2018), and even compared across countries (Garlapati, 2016; Khan *et al.*, 2014; Lepawsky, 2012; Nnorom & Osibanjo, 2008; Oliveira, Bernardes & Gerbase, 2012; Ongondo, Williams & Cherrett, 2011; Salhofer *et al.*, 2016; Sthiannopkao & Wong, 2013; Torretta *et al.*, 2013; Zeng *et al.*, 2013). Studies on WEEE management systems and practices in developed countries have recently started to receive some attention (Ciocoiu, Burcea & Tartiu, 2010; Dias *et al.*, 2018; Manomaivibool & Hong, 2014; Rousis *et al.*, 2008; Yang, Lu & Xu, 2008). None of these studies investigated WEEE management systems and practices in South Africa.

Previous quantitative studies on consumers' e-waste recycling and disposal behaviour have generally focused on developed markets (Hansmann *et al.*, 2006; Lizin *et al.*, 2017; Nixon & Saphores, 2007; Saphores *et al.*, 2012; Tonglet *et al.*, 2004; Ylä-Mella, Keiski & Pongrácz, 2015). There are only a few that examined consumers in developing markets (e.g. Echegaray & Hansstein, 2017; Nguyen *et al.*, 2018:3; Wang *et al.*, 2016; Zhang *et al.*, 2016; Zhong & Huang, 2016). South African household e-waste consumers have not been studied to identify the drivers and inhibitors of their e-waste recycling behaviour. This study has however filled this gap by applying the TPB to e-waste recycling behaviour intentions of South African consumers.

The current study has contributed towards the development of a framework for the re-use, recycling and disposal of waste electrical and electronic equipment in South Africa. Based on the researcher's knowledge, it is the first of its kind to be developed and that has been informed by a mixed methods approach.

9.7.3 The contribution to the engineering management discipline

The retirement stage or decommissioning and disposal of a product is vitally import in the engineering discipline due to the increased awareness of environmental issues (Haskins, 2006:3.1). The retirement stage of WEEE products has been addressed in this study and the negative consequences from unsafe recycling practices would be reduced if the findings were to be implemented. The study addressed financial issues, logistical arrangements, social factors, environmental protection, management models, supply chain management, and technology management to mention a few (IEEE-TEMS, 2019). Contributions to the engineering management discipline were made in the following areas:

- **Social**

The study proposed measures to address the e-waste problem. Exposure to toxic elements would be reduced resulting in limited cancer and deaths caused by unsafe practices. A contribution was made by addressing the e-waste related social issues.

- ***People***

The important role of consumers in the value chain was exposed. The attitudes, perceptions, drivers, and inhibitors were revealed and a contribution was made with the suggested measures that will motivate consumers to become part of the value chain and contribute to environmental protection.

- ***Framework***

A conceptual framework was presented in this chapter. The framework was developed using a mixed methods approach. Valid and reliable results support the framework. The framework is thus an original contribution to the engineering management discipline, and a roadmap to manage e-waste in South African.

- ***Sustainability***

The ultimate aim is to get an e-waste recycling system going in South Africa, which is sustainable in the green economy market. The researcher involved many stakeholders in the e-waste industry, including consumers, producers (importers and local manufacturers), retailers, collectors, recyclers, environmentalists, and Government entities. The integrated methodological approach, where different stakeholders' views and experiences were elicited, addressed financial and environmental sustainability. A contribution was made as the researcher addressed health and safety issues.

- ***Supply chain management***

The poor performance in the South African e-waste recycling industry is indicative of a value chain which needs attention. This study addressed the issue as the current limiting factors in the e-waste value chain has been investigated and highlighted. Proposals were given which will strengthen, transform, and manage the current (limited) e-waste supply chain. A sustainable e-waste recycling value chain roadmap was thus developed and a contribution was made to the e-waste supply chain management domain.

This study exposed the current factors that obstruct the effective management of e-waste in South Africa using engineering research approaches. The role of all stakeholders has been highlighted in the study and implementation will see an effective, and sustainable e-waste recycling industry for domestic equipment.

A significant contribution was made in the engineering management discipline with the development of the encompassing management framework.

9.8 LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

9.8.1 Limitations

As in any research study, limitations are a given. The following were limitations of the current study:

- ***Finance***

Although some financing was received from the Department of Higher Education, the study could have been expanded if more finances were available. The study was limited to urban household consumers and could thus have been expanded to include rural communities. In rural communities, the data collection process is likely to require door-to-door data collection using trained field workers speaking the specific local languages in the areas. This will be time consuming and requires funding to compensate field workers.

- ***Sample size***

The sample size of 522 was large enough to do effective statistical analysis in the form of SEM. The South African population is close to 59 million (World Population Review, 2019), which means that the sample size is relatively small compared to the total population. Statistical inferences could not be done for the South African population. Linked to the previous point, more finances could ensure a statistical representative sample of the South African urban household population.

- ***Retailer participation***

During the qualitative phase, the researcher could only get one participant representing a major retailer to participate. The participant represented a retailer that is an importer, seller, and refurbisher, with expertise in e-waste management in European countries. This participant added valuable insight into how e-waste should be managed in the South African environment. Multiple efforts to include other large retailer groups in the research were however unsuccessful, consequently, the researcher could not obtain the views from such groups selling electrical and electronic equipment in South Africa.

9.8.2 Recommendations for future research

The following e-waste related topic could be considered as future research avenues:

- ***Rural e-waste consumer investigation***

The drivers and inhibitors to recycle e-waste should be determined for rural South African consumers. The study could consider aspects such as rural e-waste collection initiatives, e-waste collection reward preferences and possible recycling or refurbishing opportunities.

- ***Recycling fee***

The research indicated that a recycling fee is needed to establish a PRO and to fund the PRO operations. Currently no financial model exists to ensure financial sustainability of the system. The recycling fee of countries should be different due to factors such as travelling distances, floor space rates, labour force salaries, and recycling infrastructure. Research is needed to determine the recycling fee on different EEE items, which would be payable by the producers.

- ***Toxicity levels on landfills***

No South African studies could be found on toxicity levels that are e-waste related. Research could thus be done to determine the toxicity levels caused by e-waste on landfill sites and surrounding rivers or underground water reserves. This could persuade the South African Government, producers, and consumers to act proactively and put effective mechanisms in place.

9.9 CONCLUSIONS

Chapter 9 summarised the outcomes of the study. The aim and objectives of the qualitative, the quantitative, and integration phases were given followed by the structure of the chapters. A discussion of the qualitative, the quantitative, and the integration results were given. A framework for the management of e-waste for the urban South African household was proposed and discussed. The methodological and theoretical contributions made through the study were highlighted. The chapter concluded by showing the limitations of the study and giving recommendations for future studies.

ANNEXURE A

6.6 Theme 1-WEEE Collection methods in South Africa

6.6.1-Kerbside placement and disposal of small and large e-waste appliances

-Cherry picking and kerbside placement is problematic

P1ES: “We have irresponsible picking that happens, and the hazardous components do ultimately end up in a system where they shouldn’t be.”

P1ES: “...here’s also a perception that people putting it on the pavement, that the scavengers would come and take it, and then you end up with smashed components all over your driveway.”

P1ES: “Because they [referring to scrap metal dealers] cherry pick as well...”

P1ES: “The problem then becomes then as soon as they then realise that, you know, they just pulled out the copper out of the system, there’s way more value in just the copper they can get out of the system, so then you end up with the same problems coming through.”

P1ES: “The problem with the informal sector is that the informal sector is virtually impossible to manage, and they will cherry pick”

P1ES: “The informal side of things will never work, we’ve tried it, and the problem is, that if you look at the price of copper, an informal dismantler or street dismantler will smash a thing apart, pull the copper out and leave the rest of it there.”

P2ES: “Yes, but there’s a proviso, and the proviso must be that it can’t stand there for any given period of time, because then what you think you are doing to benefit, you’ll go five items back, because people will come and take that waste, extract the value and then just dump the invaluable items, and that can’t work.”

P2ES: “...and the most important thing in my view right now, is in this waste pickers, they are the most exploited, and what I mean by that is, they over a time have learnt what’s got value, so they collect that waste, and there’s a criminal element that’s moving particularly in the landfill sites, and they now start dominating those people. They have to bring all collectables to this group of people, and they pay them next to nothing for it,”

P3ES: “It’s totally unacceptable, ...people putting things on the kerbside, ...because we know that most of the worse practice taking place in South Africa, people burning cables, smashing equipment, that comes from this type of complete uncontrolled release of electronic equipment, waste electronic equipment into the environment.”

P3ES: "Also e-waste is a hazardous waste classified as hazardous waste, so already by definition we are not allowed to put it into a household bin or onto the curb side...as soon as it touches the curb, it now becomes the local municipality's responsibility, and unfortunately their mandate is for disposal, and the municipal systems act they're responsibility is for disposal, and unfortunately in South Africa we don't have the right sort of resources to check through everyone's waste, and so essentially it just gets thrown away, unless it's been separated into a proper system..."

P5GA: [Researcher Question: "Do you think putting e-waste on the sidewalk is an answer?"] "Not at all, because we classify it as hazardous waste. It's not that ... you see, you've got hazardous waste now, I'm keeping it now, but unfortunately the moment it starts leeching out, it's a bit of a problem, but it's still classed as hazardous waste, I think the authorities will never allow that."

P5GA: "...because basically there's no value in it [Referring to large appliances], because the guys will strip it, first they will take the motors out, then they will take the metal that's out of it, they also take the plastics out of it, and a lot of things are sort of already moved away, before it actually ends up at the material recovery facilities, or the drop off for the municipal facilities, ja....But in all likeliness now, it's really going to fall into the wrong hands. When materials, any materials, fall into the wrong hands, then you have the typical value behavior in terms of cherry picking that would take place."

P9GA: "It will become a problem [referring to placing e-waste on the curb side] just as any other waste, I mean we see it with all the other waste, with paper, with plastics, with PET bottles, people are doing that..."

P10GA: "So it's dangerous, because somebody may want to dismantle it, especially when you look at the waste figures, they would want to dismantle it so that they can extract certain components of the e-waste, but they don't know the danger of that. So it's very also critical, even the reclaimers, or the waste pickers, they should be taught about the e-waste, what are the danger of the e-waste, especially when they dismantle."

P10GA: "Because they just pick up, they go and dismantle, they take whatever they take, and then they throw everything back to the environment."

P10GA: "...some of them think ja, maybe it's working [referring to curb side e-waste], when they get home it's not working, then they dismantle it....To get the copper, or whatever, the stuff that they can search."

P10GA: "...but with a smaller "Nyana" [meaning little] waste like your iron, your kettle, your phones, most of the time the residence would put it together with the dustbin, just next to the bin, because they know within no time it will disappear, the waste pickers or the cleaners they will take that one to go and try to reuse it,"

P11GA: "...as a household, or as an individual, and you are supposed to take your ... anything related to e-waste, to such a site, and that is the responsible way we encourage people, and the infrastructure we provide, to encourage responsible disposal of e-waste. So I don't think we will encourage them to leave it on the curb side, or in our wheelie bins system."

P11GA: "There are people who have make a livelihood...,going from door to door and asking for electronic type of equipment that a household wishes to dispose of, and then they will, ...they'll take it apart and take the pieces that they can get some money for, and take it to a place where...dealer."

P14RDE: "...you get your informal, if you want to put it this way, informal recyclers that go and they cherry pick and they take out the copper and the nice things, everything else just get dumped in the land fill, or it just gets disposed of in a non-environmental friendly manner."

P14RDE: "No, should never ever be done, never [referring to curb side placing of e-waste]. Number one, it's a health risk, it's an environmental risk. Health risk being people come, as I said, they cherry pick but you just go and dump it there, what's going to happen with it at the end of the day? Who's really going to come and take care of your electronic waste for you? So if you just dump it and leave it there, it's not going to get taken care of."

P15RDE: "Your problem is that if you put it on the curb side, it will slowly ... it's like leaving your motorcar there, the tyres will slowly disappear, maybe the windscreen wipers, and slowly bits and pieces of it will disappear [picking cherry's]."

P15RDE: "But you only strip it if the stuff is ... but then you also get problems with theft, because copper is a very expensive metal and the guys will make it disappear."

P17RDE: "Very few household items are produced in South Africa an even in a first world country, such as the Netherlands, they have problems to collect the valuable items such as PC's and laptops. It gets "hijacked", by collection site personnel, before being placed in the collection bins."

P18RDE: "Just to take this facility again, we have a lot of break ins here during the night, where this type of people jump the fence, and it's quite a high fence for somebody to be able to get over there, and then they come inside and they break open the locks on the e-waste cage just to get to it, and there's nothing really, it's wires, it's all broken, nothing is working."

P18RDE: "Yes, but if it's on a sidewalk, you will definitely ... it will encourage them, definitely you will find more vagrants, more walkers, or whatever you want to call them, that will go and look for these things and take it, and you know, start scratching through the bags, and it will create a problem, definitely yes."

P18RDE: "That is what they do [referring to household consumers], we know that's what they do, and this person will just take it there to the bush, take whatever he can from any copper or anything he can recover, and it will just stay there."

P19SCM: "Or could become a nuisance, could not go into a more controlled collection stream and it could be burnt, and I think in terms of materials and the different composition in the chemicals involved, you know, that could be very bad, number one, for health, and number two, for the environment. "

P19SCM: "We know that potentially rudimentary recycling practices might take place. To give you an example, if you put fine cable, let's say maybe speaker cable, audio cable, finer computer harness cable out, ultimately there's somebody that's going to consolidate all of that material, but whether that individual, or whether that organisation, you know, would be able to responsibly process the material, would be highly unlikely. You know, if you look at cherry picking in that specific practice, you would find that there's quite a bit of scrap dealing around, so there's some value in terms of its low grade copper, the fine cable is low grade copper. So that would typically be bought by the scrap metal dealer, but the scrap metal dealer is not interested in the PVC, if it's older cable, especially PVC still being used, or PVC now being phased out, but then the easiest method, or to get to the point where the seller is willing to buy the material, would be to burn the cable."

P19SCM: "Ja, I think at this point in time the rural areas here, they're just going to be looking for that little bit of value, and it's going to end up in the wrong hands and rudimentary recycling, you know, will providing, and dumping will take place."

P19SCM: "... you know, it all ends up in cherry picking, and they dump the no value, or low value material side of it, just to get to the cherries"

P19SCM: "And that would be selective separation then. Selective separation means then that all your other materials with no, or low value, would be typically picked out."

P19SCM: "Ja, once again it's that question mark in terms of you not having the assurance, you know, who will be handling it, and once again, if we know that there's not a proper industry in place that can responsibly process all of the materials. We know that dumping will take place"

P20SCM: "Ja, that's terrible." [On the researcher comment of placing e-waste on dumping sites or curb-sides]

P20SCM: "So, what they do is, they take everything, they strip them out, they will take the copper out, if there's stainless steel related stuff, there's ways how they recycle. How far they go, I don't have a clue. I don't know what dumps ultimately on the dumping site."

P20SCM: "But then it's also, they have to collect everything that we give them. They can't pick it and say; this has got a nice motor with copper, that one has got some stainless steel, they need to take everything."

- Disposal of large domestic appliances (LDA's)

P1ES: "...and if we had a proper system set up where we had a facility with a contact number and good enough public information for people to phone up a service provider and say, I have a fridge, or a stove, or several components, would you come and collect it? That would be ideal."

P1ES: "So to get someone to pick it up, I mean basically the home or consumer could phone any scrap market and request them to come and collect stuff."

P1ES: "And they will do so, they won't get any reimbursement for it, but they will collect. There's such a demand in terms of the metals, the problem is that the scrap metal places are not the right places for this product to go...because the cherry pick as well"

P2ES: “So I’ve got a collection, as you’ve mentioned, on a ... starting at a local residential by a suburb basis, by people having just to log onto the system via their cell phones, computer or laptop, pre-book a collection, specify on there what it is, and it will be come and collected there”

P2ES: “So you need to provide a mechanism whereby those items can be either dropped off [referring to small e-waste items] at a convenient place, or collected [Referring to large e-waste items]”

P3ES: “...we expect you to take your broken phone or PC to any of those outlets, because people can do this with their cars, but when it becomes really impractical in terms of size and weight, that you have actually that organisation where you have a toll-free number that you can phone, if you buy a new washing machine, that toll-free number should be supplied on that new equipment, so it would be, with regards to washing machines, the white goods association, there is an association for white goods in South Africa.”

P3ES: “So there should be, there could be a choice, I mean, if the household wants to haul out the washing machine and they have a bakkie at home, they should be allowed to also take it to the municipal drop off site, or theoretically even to the shop off centre, but in terms of a shopping centre, in terms of practicality, that is the kind of strategy that should be promoted for the heavy stuff.”

P3ES: “For large supplies, that is obviously a big one, I mean, you have a washing machine, or you have like a really heavy equipment, what are you going to do about that? I think this is where something like a business to business model would have to be expand, like if you look at HP, they offer like business to business take back systems, and something like this, I think the white goods association, I think that is something that they should incorporate as part of the EPR obligations, that they offer household collection, because otherwise those things are moving very hardly, difficult, from a logistic point of view”

P4ES: “So it’s quite interesting because different electronics have different values, so I’m sure there must be a way of working out what is a feasible collection, right, so if you say I have a fridge and it needs to be collected, can you come and collect it? They will be able to determine how much it costs and what is viable to collect, and that we have the equipment for that, right. I mean, people are buying large products and they do have the vehicles to drop and collect as well, which might happen it might even be like a sort of an Uber system, that’s exactly what Takealot does, they’re almost like an Uber system, but for collection.”

P5GA: “We haven’t done anything like that in South Africa [referring to disposal of large e-waste items], because at this stage most of those stuff [Referring to large appliances] is not, because it still got a value. So, somebody will take care of it. Most of the stuff you don’t dispose of, but somebody would give it, and it’s a good thing, because somebody is using it, and most municipalities hasn’t provide for bulk waste to take it out,”

P5GA: “It’s just, as I said, for, if you talk about poor people, obviously they can’t carry a fridge to a place like this, but you’ll see not a lot of those things, you see it only when it ends up at the landfill,”

P6GA: "I think the other important issue is how do you control it [referring to large appliances], because they will get someone to collect it, and take it away, but you don't know, you need that assurance that it's going to the proper place, so there need to be some type of tracking system to prevent it being disposed of illegally, once it leaves your premises. So, some type of waste manifest system needs to be implemented and controlled, I think, by the municipality, and you as the generator, or the consumer, needs to have that documentation to say that it's left your premises, and it's been disposed of at a suitable drop off."

P6GA: "For me personally, I think sometimes these large bulky items is a bit of a nuisance in you as a household, you don't necessarily want a reward for it, you just want it ... you know, taking up space, you bought now your new eye level oven and whatever, and your old stove, you just want it ...to get rid of it."

P9GA: "And not everyone has a bakkie [meaning a Pick-up truck] to take it and drop it off. That could be possible if you do have transport to take it yourself, otherwise there should be a system where you can call, and they come and pick it up, but it always comes at a cost."

P10GA: "So if we give a schedule, like we've got our schedule for waste collection, once a week we've got a schedule for collection of e-waste, especially the big bulks,"

P12GA: "I think something like that could work in the private sector, because the value of a lot of those high, those big e-waste items, it's got scrap metal value as well as the heavy metal value, I think, my opinion is that there would be enough in the value chain to allow the private sector to do that, and I think there are some..."

P13GA: "Just to add also on what my colleagues are saying, is that yes, that is the next cycle of a tender that we will be busy with, to look at and encompassing, and the reason why we don't have a toll free number for you to call for that purpose, that's beneficiation, whatever that you collect, there's a benefit out of it. Now if it comes with the CITY how do we beneficiate that? Now we need to go to another process of procuring the service for somebody to come and buy all that."

P14RDE: "Yes, that would definitely be viable [Referring to a system where large household equipment is collected at home]. At the moment there is nobody that's doing that, the reason being is that the fridges and things are too big,"

P15RDE: "Because otherwise, you know, if our washing machine packs up and the maintenance guy must come here, because we can't move it, we haven't got the facilities, so you must get a little bakkie, and it's a collection bakkie."

P18RDE: "Yes, we will definitely do it, if it's something that we can at least get something out of it, we will do it, it shouldn't be a problem. You see, it also goes about, you know, the waste, it's always the volume, also the pickup, you know if you send a truck there, you don't want to pick up just one fridge or a microwave or something like that."

P19SCM: "Ja, for those categories, I mean, we call it the MDA, Major Domestic, or large Domestic Appliances, (LDA), you need to look at a different type of solution, you know, in terms of the convenience factor."

P20SCM: "They would basically buy a new product, and they actually accept that you also remove the old one, because otherwise it just lands up in a garage, and nothing gets done."

P20SCM: "So, they would actually deliver it, and they're not always keen to pick it up, because what happens with that when they don't want it?"

P20SCM: "I think it will. [On the question from the researcher if he thinks a centralised, properly organised call to collect system for large e-waste will work]. In our client base, ja. If they know that there is a channel to be able to, because the type of client doesn't want to drive around with his stuff."

6.6.2-Convenience is the key to effective e-waste collection

-Corporate e-waste collection points as a potential convenient solution

P1ES: "That would be fantastic. So places of work, schools, and community centres would be ideal. Again they need to be given the facility to be able to handle that, and you want to avoid storage, because storage comes with a whole bunch of issues."

P1ES: "And that's also from a place of work perspective, can be driven, where it's a lot easier to look at your education and your awareness component. The problem that I face with that is that everybody's always saying 'what's in it for us'? So there's very few organisations who will say right, we're doing it because it's the right thing to do, we're going to collect this waste."

P4ES: "Yes, so we do, or "My Company A" does have one, and it does work in its current form. The only thing is that as companies become bigger and bigger, it becomes harder and harder to manage it, and what's from our personal experiences is that it's really difficult to manage waste, unless you have a bastion or someone driving it, and most companies don't have anyone driving waste, because they just don't understand waste. So I definitely think it's an opportunity, but everyone has to go on board, because you really want it to be viable and so they have to get the volumes."

P4ES: "How do you coordinate that? And if you do ... That's where it comes down to having someone to drive it into a campaign for it, because then you can, it does become possible. So I think it's an opportunity, it's just, you need people to drive that, and that's how far, the number one thing, is having someone to drive..."

P9GA: "That's a good idea [Referring to the suggestion of company drop off areas]."

P10GA: "It's a good idea [Referring to corporate collection points] if you've got a lot of people, then get people to collect at different collection points,"

P16RDE: "Ja, definitely. Lots of our clients is self-due take on the responsibilities with recycling to a 'T', so they do provide it, and subsequently they do pay for it to get collected and that model definitely works, Conlog is a good example of that. They have a battery collection for penlight batteries in their canteen, and all their (people) are encouraged to drop off their batteries there, so those little models definitely work and they do eventually go to the right people because they are compliant companies. So I definitely think that definitely helps."

P18RDE: "In any facility it goes about money at the end of the day. You know, if there's facilities that the city will make available to people like us, or companies like ourselves, definitely we will do it, you know, and set up again like a drop-off area for the people where they can take it. I know some companies use containers that they place in certain areas, and you can take your cardboard there, you can take your e-waste there or whatever. Places like Makro, somewhere on the side, there is a place where you can take it and drop it off."

P19SCM: "That factor in terms of typically where you would go or would have peers around you, and once again feel comfortable. Also, I think in terms of peer pressure you know, to be seen to be doing the right thing, I think people discard this, but you know, I think even if you look at your retailers, if you look at Makro, that's got the bins outside the parking lots, you know, I've seen people that would ... that could have only spent, let's say a few seconds around the bin, but they stand there for a few minutes, because they want people to see them depositing it."

P19SCM: "...so hopefully when you entered our site you saw my collection bin? ...That's my collection bin. ...Ja, and I think that, you know, once again it needs to align well with that convenience factor"

-Current and potential allocated drop-off points

P1ES: "When it's a drop-off centre, because some people feel more comfortable taking it to a drop off centre, where it's not outside their yard."

P1ES: "And I know that there are initiatives in place to look at setting up multiple drop-off centres around the country. We have still yet to determine who the responsible authority will be for educational awareness component, but I think that's coming through some of the discussions at PAKISA at the moment,..."

P1ES: "And I know that there are initiatives in place to look at setting up multiple drop off centres around the country. We have still yet to determine who the responsible authority will be for educational awareness component, but I think that's coming through some of the discussions at PAKISA at the moment,"

P2ES: "At a large shopping centre, and even the small shopping centres are ideal places for that, because consumers are going there"

P2ES: "So you need to provide a mechanism whereby those items can be either dropped off at a convenient place, or collected"

P2ES: "The consumers' responsibility must be that they must be made aware of what the potential hazards are around having the e-waste and disposing of it in an irresponsible manner, but then the system via the producers, must provide a mechanism whereby waste can be disposed of conveniently, safely at no cost to the consumers."

P3ES: "So I would say, whilst the households need to take the basic precautions of avoiding any breakage or spillage, okay, it would have to happen on those drop off sites that the municipality runs. It would have to happen on any mass collection points at a shopping mall or something, that you have someone that is actually there typically employed, with the knowledge to separate those streams."

P3ES: “There are a lot of big shopping malls in South Africa. Those are ideal places, they could be manned, part of the parking lot should be allocated as a drop-off hub, where people can return all type of packaging, waste, including also electronic waste, and that’s something where I would like to see some collaboration with packaging SA and I’m also busy right now to fulfil the EPR obligations.”

P3ES: “It’s the same thing. We don’t call it a garden site, because it’s a point where you as a household can bring back all kinds of recyclables, you can also bring your builders rubble, you can bring your greens, and most of them are also now equipped with a container that’s specifically dedicated for the collection of electronics an electrical waste, which is a good thing, but as I say, it depends on ... there needs to be a tight control on the actual operators of those garden sites, or drop offs, whatever you want to call them.”

P3ES: “I would be feeling much more comfortable of retailers, assuming the key responsibility, shopping centres, I know that pilot projects were quite successful, where the big recyclers, such as Desco, would provide like proper, big containers in key mass electronic outlets like Massmart group, like Makro. I think those are definitely, it should be very focused on the retailer, with regards to collection points.”

P3ES: “Okay, the responsibility of the household consumers would be to take back where it has been bought. So I think that is a responsibility that should be legally enshrined, like for the retailer, the responsibility is to accept the take back, it should be a legal responsibility for the household to bring back. So the responsibility I would assign as to any household is to bring back, and that should be legally requested. “

P4ES: “We have a lot of aggregation potential in the sense that all of the aggregation points, such as drop-offs and material recovery facilities are owned by municipalities, so the infrastructure is then built by a municipality, but it’s actually runned by a private sector, okay. So what happens there is that it actually is in the best interest for private sector to promote e-waste separation and to come drop it off. But what is also interesting is that in ‘City A’ specifically, is that there is a drop-off every seven kilometres from anyone, right, so there are places to drop these off, municipal drop-offs”

P4ES: “So there’s quite a few schools in and around who already do have a great waste separation initiative, but because they’re dealing with lots of children, and with lots of parenting dropping their children off, it’s a great opportunity to capitalise on that and start having a section for e-waste as well. Malls is a good one. We currently work with a company called ‘Square Mobile’, it’s sort of a very informal and local micro-enterprise, and their role really is just to facilitate these sort of drop-off areas for people to drop off their e-waste and malls”

P4ES: “I know what often happens is ... there’s a company in ‘City A’ who, once a year, has a collection area, where people from the neighbourhood can come and drop off their e-waste, they just need an excuse like a coordinated plan to drop off where ... and then that happens once a year”

P5GA: "...if you bought something and you have to do something with it, it's your responsibility then to look for a place where you can dispose of it legally. Unfortunately, there's not a lot of municipalities that makes provision for it. So, I believe that there must be specific provision in some municipalities, like 'Municipality A' in the 'Region A' area, they make provision where they, at their drop offs, they are allowed to take that out. 'Municipality B' municipality has also got a similar thing where they allow to go to a drop off and they take it out and you got 'City A' side at this stage."

P8GA: "Currently, with the municipalities, as P5GA indicated, with certain municipalities there are no systems in place. So, what they will do, they will actually take that, you know, the tubing, and just put it in a normal bin, but in terms of exposure, there's exposure to the trolley guys, and also the municipalities that collects that, unless they have a special container in which they will actually place that, fluorescent tubes, but then the responsibility will become that of the municipality, in order to dispose it, in terms of cost wise."

P9GA: "I mean we do have receptacles in shopping malls and we have a Desco is a recycler who's put a container at Makro, you can just deposit your old computer, laptop, TV, whatever, there"

P9GA: "The third option would be of course, dropping it off at a nearest drop off centre, it could be at a filling station, it could be at your nearest supermarket, it could be at a mall, whatever is convenient for you, that is accessible."

P9GA: "That's a good idea. That is already happening in a lot of areas as you know, I mean we do have receptacles in shopping malls and we have a Desco is a recycler who's put a container at Makro, you can just deposit your old computer, laptop, TV, whatever, there"

P9GA: "I think I can take it to a point, a central point where it can be collected."

P10GA: "I don't know, but if we've got the facilities where we can take all this, and then they can be claimed from there..."

P10GA: "...as I said, we have a place where, whether at our garden site, maybe our garden site we can turn them into also integrated waste management system, where we can have a place, or we can store our e-waste, and then maybe later it can be sold to a credible company that will come and take that e-waste."

P10GA: "...but with the big appliance it's very tricky, and remember also, with Pikitup, Pikitup introduced a system to say the bulk waste should go to ... whether it's a mattress, whether it's a couch, whether it's a fridge or it's what, it should go to the nearest garden site and then maybe somebody can come to the garden site and reclaim it, but remember, not everybody got transport, or not everybody knows about that services."

P10GA: "...but I think the easiest way to integrate everything is through our Pikitup garden site, because we've got lots and lots of garden site, although not in all our areas, but maybe going forward, when we build the garden site, we should build it in such a way that it will accommodate all type of waste, especially e-waste, because e-waste at the moment is still a big challenge."

P10GA: Those that can, if they see no, they can't wait for this collection date, they can just drive with the bakkie and take the e-waste through to the garden site where it will be collected by a recycler, or an accredited service provider that admit e-waste recycling."

P10GA: "And also our garden site né, in areas where there are facilities like garden sites, you know in Pickitup you said you are going to change that, it used to be garden site, but now they are changing them into integrated waste management system, where the residents can bring their garden site, their green waste, their builders rubble, if it's smaller, the size of a wheelbarrow, your bulk waste, because some people they don't know what to do with their old mattress, their old fridges, it's sitting at the backyard creating rats and everything. So this route that we are going, so at the moment we are putting infrastructure at the garden site to accommodate other recyclables."

P10GA: "You know what, I think those stores they should be made responsible for the waste that they generate, maybe let's have the bins, like I've seen this nowadays, most of the shops, Makro and whatever, they have the bins where people can go and drop those recyclables so it should be from the industry be imposed, not imposed, but regulated, one way or the other, to force the retailers to take responsibility on the waste that they sell to the community. Have bins, have service providers that are coming to collect those recyclables, that e-waste recyclables."

P11GA: "The ideal situation would be for there to be legislation that says, if you have a broken fridge or a broken computer, or a broken whatever, then you have to take it to your local drop-off site."

P11GA: "...as a household, or as an individual, and you are supposed to take your ... anything related to e-waste, to such a site [Referring to a drop off site specifically designed to collect recyclable materials], and that is the responsible way we encourage people, and the infrastructure we provide, to encourage responsible disposal of e-waste. So I don't think we will encourage them to leave it on the curb side, or in our wheelie bins system"

P12GA: "So it's basically a fenced-off area with some containers and equipment and some undercover facilities, and the e-waste is stored in a container, so it's not accessible or exposed to the weather."

P12GA: "So there is a kind of a safe place for them to drop it off, and then our recyclers, which are contracted on those sites, can have that e-waste for recycling."

P13GA: "It is very safe, because there is a SOP, Standard Operation Procedures that we give all the contractors that are on site, and then the drop off sites they got the licensing conditions that they operate within, any transgression to that, the contractor gets penalised. We have different activities on site, to chipping, polish, recovering and sorting of recyclable materials. Now that will form part of the e-waste collection that form part of the recovery and sorting of those recyclable materials"

P13GA: "Hence, ...the drop-off is the way to, unless individuals, which we do have individuals that go and knock from time to time to have such waste, and they will take that waste, and obviously they will dismantle it and take whatever that they need, and the rest they will discard through it there, or take it to the drop-off."

P13GA: "...one of the services that we procure, is the one for the drop-offs, that all communities, that their waste cannot fit inside the bin. They will take their waste to the drop-off. Not general waste or domestic waste, any other thing we normally say it's garage waste, you take it to the drop-off. That's what it serves the purpose for. Also the green material and builder's rubble they will be taken there"

P14RDE: "So, you know, I would say there should be places allocated, safe areas, that's not exposed to the elements, if there's precipitation, no water gets ... doesn't get in contact with, the environment is closed, it's sealed away, things can't get taken out, points like that should be build, and like what we do, as I said, we've got containers all over the whole of South Africa."

P14RDE: "I foresee it [referring to a take back program], yes, and I think the government should be in on this, once again, but as I always keep on reiterating, it should be your manufacturers and your suppliers, they should become more....they should invest, they should become more attentive and start doing more for there,"

P14RDE: "...the home owner, or the consumer, at the end of the day, shouldn't be on this on his own, he should have the assistance of the people where he purchases the items from, to inform him as well. So if you want to get to dispose of your electronic waste, we would like to say to you, these are the people that you can contact, or please, do contact the responsible recycler to assist you with the recycling of your electronic waste"

P15RDE: "I would say what you need to do is go to retail outlets or shops where women normally go to, and from the household, just throw it in the bin."

P16RDE: "Ja, definitely your outlets where you purchase the stuff, because that's the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you're buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what's ... ja."

P16RDE: "It goes back to ... there's Makro, or there's Builders Express, which sometimes had bins, some don't have anymore, some do. So ja, you go to them or you go back to where you were, because most of them would at least still have some kind of a solution what they're working with."

P16RDE: "Ja, definitely your outlets where you purchase the stuff, because that's the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you're buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what's ... ja.'

P16RDE: "A little reverse logistics. So when someone delivers the fridge, they must take the fridge back out, and like a battery component, lead acid batteries has got something very specific like that when they pay there, I think your deposit system is like R150 and that works really well, so ja."

P18RDE: "In any facility it goes about money at the end of the day. You know, if there's facilities that the city will make available to people like us, or companies like ourselves, definitely we will do it, you know, and set up again like a drop-off area for the people where they can take it. I know some companies use containers that they place in certain areas, and you can take your cardboard there, you can take your e-waste there or whatever. Places like Makro, somewhere on the side, there is a place where you can take it and drop it off."

P19SCM: "You know, it should not involve inconvenience, you know, to make that decision, what do I do with it now, or I could maybe do xyz, but rather not. You know, maybe I would feel not safe, let's say maybe go into my local municipal dumping site, or garden refuge site, you know, so we should empower the consumer, the household, to make an informed decision, and I think there and then really lies the problem, in terms of education, and in terms of the eco-system that's not in place in South Africa. I think the biggest factor there for me is that households can't make an informed decision, because they are not properly informed."

P19SCM: "Once again we should see how we can integrate and how we can work with the consumer, and then rather tell the consumer you can't do this, and we're going to fine you if you do this, you know. So that would be a no-go. So number one, the method needs to be convenient."

P19SCM: "So ja, I think it needs to be visible, it needs to be convenient, you know, once again, and it needs to be at points where you would attract sufficient volume."

P19SCM: "And then, if you need now start with education on awareness, you cannot take a toaster to that point, and you can maybe take a washing machine there, it's just going to be very difficult for the household."

P19SCM: "But once again, with convenience come education awareness."

P19SCM: "But it should be very convenient, it should align with the consumer or the household members' daily activities, daily commute, weekly, you know, visiting family, it should just fit into the lifestyle. ...And I think then you're going to ... then you're going to stand a better chance to unlock, you know, stock piles, currently, in their households."

P19SCM: "...so hopefully when you entered our site you saw my collection bin? ...That's my collection bin. ...ja, and I think that, you know, once again it needs to align well with that convenience factor"

P19SCM: "Ja, for those categories, I mean, we call it the MDA, Major Domestic, or Large Domestic Appliances, LDA, you need to look at a different type of solution, you know, in terms of the convenience factor"

P19SCM: "That factor in terms of typically where you would go or would have peers around you, and once again feel comfortable. Also, I think in terms of peer pressure you know, to be seen to be doing the right thing, I think people discard this, but you know, I think even if you look at your retailers, if you look at Makro, that's got the bins outside the parking lots, you know, I've seen people that would ... that could have only spent, let's say a few seconds around the bin, but they stand there for a few minutes, because they want people to see them depositing it."

P20SCM: "I think it can work." [On a question if the participant think that the placement of containers at shopping centres will work].

P20SCM: "To say wow, okay, that's great. Now these chaps, they think about recycling, but you can drop any brand of any appliance in there. Again, the practical thing is that somebody needs to control it. So, is there somebody at the container to open it up and put it in? Or are there people that's going to scrunch and open it up and take stuff halfway out and make it a mess? And then, of course, at a shopping centre you want to have a clean environment, so preferably ... We even looked at this centre, we looked at recycling as well, because it's so high on the topic."

P20SCM: "Ja, we basically always try to avoid it, to get an item back, because what do I do with it?"

P20SCM: "No, we don't." [On the question if the retailer has space to store e-waste].

P20SCM: "...because you can't work at a R100.00 or R200.00 a square."

6.6.3-Authorised mobile e-waste collection

-Authorised and organised e-waste collection entities

P1ES: "According to me it should be collected by authorised responsible collectors who are going to take it to centres where it will be properly dismantled and/or refurbished."

P1ES: "You cannot work with the informal sector, it has to be formalised, it has to work according to norms and standards, where we are going to maximise the value coming out of that waste stream. It's also got to be compliant within the environmental regulations and requirements of the country. The issue that we face in terms of e-waste currently in terms of legislation, is the problem is that, because it's still classified as hazardous, your collector now has to have a hazardous transportation license to pick that stuff up, which is ridiculous."

P1ES: "So we're trying to change that regulation as well, but it has to be done formally, according to areas, where a contract is appointed and has accountability and responsibility to collect on a particular day and to take it to a particular point, it's the only way it can work."

P2ES: "So you should have like in some cases where they say on certain days they collect e-waste. You put it out and it gets collected"

P3ES: "...but I think there is a huge opportunity with mobile collection units, and if you look for example at the packaging industry, they just started now a pilot project called "PACKA-CHIENG", where they have actually a mobile solar driven thing with a scale and actually with a baling unit that they take to the townships and then people can bring packaging waste, they have actually become undersigned with MasterCard, so people have a moneyless system."

P3ES: "...for example, we have a lot of those central improvement districts in industrial areas, like 'Suburb C' Industria, 'Suburb D' Industria, so that would be a very easy way to work with those central improvement district managers, and make a dedicated e-waste collection day for a particular industrial area like 'Suburb C' or 'Suburb D' Industria, and make a nice little media release about it, get the radio people out there, and have someone like Desco, with the collection facilities, which are mobile on the day"

P3ES: "...what I'm saying is, part of the solution, absolutely yes, that you offer this for commercial that you have an e-waste collection day, specific marketing and your target key commercial areas, and industrial zones"

P5GA: "So, you'll have to establish some sort of mobile facility. That's not there always, but it's there maybe once a month, that can go in and then getting it out. So, at least you'll have a way of collecting it, and then taking it out. I remember, because the distances are quite big, and transport is a big cost driver there. You'll have to have a system of that it be funded by the bigger scheme of things, where transport is not a big problem in 'City A', but you'll have to subsidize in the sense, otherwise non will be recovered in the smaller areas, but definitely the smaller areas have problems down there, they don't have the facilities because their economy of scale is just too small, and it's too expensive then to have a big system for two or three fridges, or ten fridges and stuff like that, but I've seen now, I think it's in 'Suburb B', they started with a process where they start getting certain waste types out, and they don't have a facility there, say seven days a week, they come once a week and then they bring it in, like a mobile centre, you bring it in, you take it out, then they take it away, and they've got a system of how they pay the fee also. So, I really think something like that would work in the rest of the province"

P5GA: "So, you'll have to establish some sort of mobile facility. That's not there always, but it's there maybe once a month, that can go in and then getting it out. So, at least you'll have a way of collecting it, and then taking it out. I remember, because the distances are quite big, and transport is a big cost driver there. You'll have to have a system of that it be funded by the bigger scheme of things, where transport is not a big problem in 'City A', but you'll have to subsidize in the sense, otherwise non will be recovered in the smaller areas"

P10GA: "You know, a bit tricky but I think the best method is if, as a municipality, let's say we have a collection day for our normal bin, maybe once a week, in certain areas, in the areas we say once a week we've got a collection day for all the e-waste, especially the big items, and you know, in the urban area it's easy to collect, unlike in the rural area where we'll want to repair, reuse, dismantle, do whatever."

P10GA: "So if we give a schedule, like we've got our schedule for waste collection, once a week we've got a schedule for collection of e-waste, especially the big bulks,"

-The role and limitations of municipalities in e-waste collection

P2ES: "...the municipality utility vehicles come on a Monday and a Friday for example, you have either private public partnership, or the municipality does it on their own, whereby separate vehicle follows that vehicle, or they have a separate trailer attached to the vehicle where they just collect e-waste. That's a way it can work and has worked.

P2ES: "Yes, so small items can be disposed of, like say, you can have a red bag or something where you put small e-waste in, and it's easily identified when the guys come and collect the stuff they just pick up the red bag and that goes in a separate container, separate trailer, or whatever compartment, so that can be handled quite easily, because the small household items is potentially the biggest problem, because they get dumped and that lands at landfills with all the heavy metals, and they get exposed to the elements, it creates all the contamination."

P2ES: "They said well, fantastic. I said great, so let's sign the agreement. No, we can't do that, because the legislation doesn't allow us and the public finance management act has got too many complications. So that's a challenge. Municipalities, by law, have to provide a service to consumers to collect and treat their waste. But I think we have to now realise time has changed whereby we can't just say yes, that's the law, then we leave it to themselves, because it's not going to happen. Not necessarily because they don't want to do it, but because often they don't know how to do it."

P2ES: "...the municipality utility vehicles come on a Monday and a Friday for example, you have either private public partnership, or the municipality does it on their own, whereby separate vehicle follows that vehicle, or they have a separate trailer attached to the vehicle where they just collect e-waste. That's a way it can work and has worked."

P3ES: "Ja, I think so. Look, the thing is, and that is always a discussion that I have, I mean, if you have a supplier bringing fresh electronic equipment, there is no problem, there is no hazardous waste licenses required." [Researcher question: "...do you think they [Municipal truck] are equipped to pick up e-waste?"]

P9GA: "Ideally the collection method should be the same municipal truck that is collecting the waste, you know, the domestic waste, should also collect the e-waste, right, the small ones."

P4ES: "No, I don't think so. Just even if you are a general public person driving around and you're seeing the back of a truck, you often see water running out, or juices running out, and that's a problem, because often what happens is, if you start having fluorescent tubes for example, and they break, they become vapour form and they start ... they will be absorbed by organics, and what happens with organics is that it leaches out, so it starts having this heavy metal contaminated organics running out of the trucks."

P9GA: "Not currently. It's not about time, it's about appropriate infrastructure. Currently they are not equipped to do that, but in areas where they have decided to do it, I've seen, or I've heard where you have a truck that actually have a compartment that separates, so you've got ... you can tip your bin for the rest of the municipal waste, and the other ones goes into a separate compartment." [On Researcher Question: You said something about the municipal trucks; do you think they really have the equipment to do that, or the time to do that?]

P9GA: "It could work, I mean, it works in other countries, you know, I don't see why it can't work, but it will always come down to money, you know, in South Africa."

P9GA: "You know, it costs a lot of money to buy those type of trucks, and you need a good collection system, so your municipality would have to map out its routes very, very carefully and very well."

P10GA: "No, they are not equipped to handle that, but I think if it's build into the system, then we can come with other means of transport, like recyclables, we cannot collect our recyclables with a compactor truck, but at the moment, because we are doing recycling, we've got a special truck for collecting the recyclables. The same with the e-waste, I think the e-waste they just need a flat truck that is covered that can accommodate this certain size height,"

P10GA: "...so we'll have to have a special truck or the truck that we are using that can be suitable to collect that type of waste."

P10GA: "You know, a bit tricky but I think the best method is if, as a municipality, let's say we have a collection day for our normal bin, maybe once a week, in certain areas, in the areas we say once a week we've got a collection day for all the e-waste, especially the big items, and you know, in the urban area it's easy to collect, unlike in the rural area where we'll want to repair, reuse, dismantle, do whatever."

P10GA: "So if we give a schedule, like we've got our schedule for waste collection, once a week we've got a schedule for collection of e-waste, especially the big bulks,"

P11GA: "It's a costly exercise to collect e-waste to households, number one. Logistically it's a nightmare. How often will we be collecting that? Every week? Because what we say, we service your house once a week. [On Researcher Question: "So would you say that municipalities are not equipped to collect e-waste?"]

P12GA: "Ja, I think the other challenge is that, as municipalities, we have a certain type of waste vehicle, which is really specifically designed for household waste. So we would basically need to purchase a whole other fleet of vehicles, so it's a whole massive capital expenditure, plus operational expenditure of doing the collections. So the question is, I mean, we can do it, but who would pay? You know, and then we'd have to raise our tariffs..."

P13GA: "Now it would mean that we have to go back and change the policy, and try to itemise our policy to let's say change for general waste or domestic waste is once a week, for anything other than that, and still when you say 'other than that', you need to define all these 'other than', because yes, e-waste you can come once after two months, it's fine, but not with plastic, not with bottles, not with others."

P14RDE: "They're not fitted, they're not geared, they are fitted out for solid waste and things like that, not for electronic waste. So if they had trucks, and yes, they can ... I'm sure they can build trucks, or they can have skips, a lot of skips get converted to collect electronic waste, so yes, that will be viable, but at the moment the municipal trucks are mainly just build and geared for solid waste and municipal waste, not for electronic waste. Once again, the reason why I'm saying is because they crush everything in those trucks, they compact it, so imagine if you've got a whole lot of cathode ray tubes or fluorescent tubes, all these kind of things ..."

P14RDE: "You've got that in there, it gets crushed and compact, all those materials get exposed. You've got toners, you've got cartridges in there, all that material gets crushed, exposed, it gets opened up, and that's where the hazardous fractions then become a problem, because now you've got all of this hazardous material in that truck that's been crushed, where does it go to? They just tip it out, and where do they tip it out, and what happens with it?"

P15RDE: "Yes, but municipalities I don't think are motivated to do it. You'll need to motivate them. People like, what's it, the recycling people would be interested in doing that, and they've been struggling with that for a long time."

P16RDE: "Ja, you pay your municipality, you think they should handle your waste correctly, but they don't, so once you go back to the municipality and say you're handling it correctly, because that's what we're paying for..."

P16RDE: "I pay my bills so I thought it might be done properly, I'll help where I can, so we can need more bags on these different days, but as an individual would you hold me personal reliable for ... ja, of course, because it's your actions, but if you're paying someone to do it, there's your action too."

P16RDE: "...are their systems in place? Definitely not. Are they equipped? Ja, of course, they handle much bigger items, less, more toxic, more ... but again, you've got a municipality already dealing with e-waste, someone ... the departments don't even know what they do, so how do they're going to get them to ... so ja, a long struggle, but ja, it's possible, definitely,"

P18RDE: "No, it will be ... because they use contracted trucks. They don't just want to put it in, because they're concerned that it will break the trucks or cause problems. It needs to be open and caged vehicles like our vehicles."

P20SCM: "I think my question would be, what happens with it ultimately – are they going to do something decent with it, or is it going to fill up a landsite?"

P20SCM: "And it's quite tricky with appliances, to what can you take out of it. It's not as simple as you've always got big volume."

6.6.4-Rural area e-waste collection

-Rural areas need different incentives

P1ES: "The informal side of things will never work, we've tried it, and the problem is that if you look at the price of copper, an informal dismantler or street dismantler will smash a thing apart, pull the copper out and leave the rest of it there."

P1ES: "It's a complicated one, because rural area collection, again it comes down to the problem of perceived value of the equipment. Your rural person is going to want something for it. They know there's copper and aluminium and other bits in there, and they would rather pull it apart themselves, than give it to somebody."

P2ES: "So the old school people, like the baby boomers, like ourselves, we find it more difficult to make that change. If you take the millennials now, they are very conscious about the environment, so they are more prone to do it, but right now they make a small percentage of the economy. So to ensure that people do the right thing, if you make it easier for them, or there's some incentive, and the incentive doesn't always have to be cash, there can be many other forms of incentives, then you've got a higher chance of success, and then after time it will change behaviour, and then you can start cutting back on those incentives, once the behaviour is in place."

P3ES: "So where is the stuff? Very simply, it is still at the households. So we went actually to the townships, and I had a guy who speaks Xhosa, and he was ringing on the doors, and we had this very grassroots exchange of information of 'do you have at the moment phones?', 'do you have at the moment a computer?'. Yes, yes, yes. 'What would it take for you to give it away?' and it was very clear that people said they want something in return, and no, they don't care about a tree that gets planted, I mean, that was one of the things that they did for example in Sweden. So people have a higher income class, they can afford themselves the luxury of environmental consciousness, for them it's good enough to know that they're planting a tree on their behalf when they return their equipment".

P9GA: "But if they're just doing it for the greater good of the environment, you know, it's still something that is up there, they don't see the direct link." [Referring to rural area people]

P10GA: "It can work, but it depends on the area, it's not a one size fits all, some, especially in the suburb, because to them recycling is not an issue, we'll be happy to pay a recycling fee, but imagine me staying in an informal settlement, not affording to pay a bread, not affording to take my son to school, and you expect me to pay a recycling fee."

P10GA: "Because in the rural area we don't just throw anything, we will keep it ... I don't know how many irons I have in the house, or at home, but they will keep it, they will want to go and sell it and get something. So in the rural area is an issue of job creation, you go and sell or you exchange with something, or maybe you can start a program to say bring all your electronics that are not working, in return we will give you a food package, or a vegetable package, you know, some incentive, but not for free, otherwise you're not going to get it. Else it will pile and pile, the next thing it's all over the landfill site."

P18RDE: "They're interested, but to take it themselves, but anything that they cannot use, they will not bother and they will just chuck it in the field, or bush, or any place they find. There's no real concern about it. So I think definitely we will struggle, they'll accept if you start paying the people for it, and you know, then they will take it to a point where they can sell it, and then they will be interested, otherwise definitely it will not be done, I think you're just going to waste your time"

P18RDE: "Yes, urban areas you will get it right there, but not the rural. Again, the rural ... because, you know, it's easy for somebody just to chuck it in the bush, next to the house or anywhere"

P19SCM: "That factor in terms of typically where you would go or would have peers around you, and once again feel comfortable. Also, I think in terms of peer pressure you know, to be seen to be doing the right thing, I think people discard this, but you know, I think even if you look at your retailers, if you look at Makro, that's got the bins outside the parking lots, you know, I've seen people that would ... that could have only spent, let's say a few seconds around the bin, but they stand there for a few minutes, because they want people to see them depositing it."

P19SCM: "Ja, it all depends on the community, you know, it all depends on the area. I think different areas, different communities are interested or has a different need, so I think, you know, value is value, if it's reward points or Clicks points or ..."

P20SCM: "So, that's why, sometimes it's very skew where we work more with an affluent client base, compared to ... the masses."

-Rural collection ideas and community empowerment

P1ES: "in order to maximise the job creation, the idea would be to set up small facilities, where you've got a quick throughput, we don't want a collection and storage of materials, you need a quick throughput of materials, you need trained staff who are able to separate out your plastics, your metals, your boards, your glass, and all the other different components separately, and those have direct market offtakes immediately"

P1ES: "That would certainly drive that market. The issue around the rural areas is communication and logistics. There's a lot of places out there where you're just not going to get to. That's where I would think your rural areas are better off with drop off centres."

P1ES: "Where they would act more as a buy back centre, somebody can bring their stuff into a certain area and get paid a certain amount for it, but physical collections very difficult to do, and I think anyone who tries that is going to lose money"

P2ES: "So you need to create unsophisticated systems that will achieve job creation, will achieve education. Then I think we have a system that's sustainable, that will also work in a long term interest of the country. That's just my thought, and that's the model that we're running out."

P2ES: "What you need to do there, my view is, in those areas there has to be an extended process, whereby ideally you want to create collection points, or materials recovery facilities, that treats more than one waste, or collects more than one waste, because then it becomes a little bit more sustainable, and we need to apply, and that's part of our industry waste management plan, we need to apply a little bit of technology into those areas to make it more economic, to get the waste to where it needs to be treated"

P4ES: "...sort of an out of the box thinking, if I think about it, because everyone technically goes to a [Inaudible] communion in rural South Africa, a lot of people do go to church, it might be a very fancy church, or it might be some sort of church, but ... So that's from a more formal side, from a not so formal side you probably have ... the next best place is places like spazas, where you have these stores where people often come into purchase things all the time, and it might be a great place to aggregate and then to move onto a larger spaza or shop or another co-op."

P5GA: "...but unfortunately if you're in a more poorer area, I think, obviously you don't have a vehicle, so you'll have to have another system of getting it out."

P9GA: "And that setting works better in an urban environment. In a rural setting you could partner with schools, I mean there's always a school close by. Or partner with clinics, you know, all those public...and churches, all facilities that are accessible to everyone, and put the receptacles there, but of course we know with all of this, it takes a lot of education and awareness."

P10GA: "Because in the rural area we don't just throw anything, we will keep it ... I don't know how many irons I have in the house, or at home, but they will keep it, they will want to go and sell it and get something. So in the rural area is an issue of job creation, you go and sell or you exchange with something, or maybe you can start a program to say bring all your electronics that are not working, in return we will give you a food package, or a vegetable package, you know, some incentive, but not for free, otherwise you're not going to get it. Else it will pile and pile, the next thing it's all over the landfill site."

P10GA: "You know e-waste in the rural area, remember, in the rural area is an issue of job creation. I think in the rural area we can have, if we've got the area or the site, or the garden site where people can take the e-waste or the collectors, they can have collectors that are collecting, and then the accredited service provider can teach whoever is operating that site, how to dismantle in a safer and healthy safe method, so that they can be able to generate the money, but also remember in the rural area I can't just take my e-waste to go and dump it there, I want something in return."

P10GA: "So maybe something like a buy-back centre where I can be able to sell my iron maybe for a small fee, and they will dismantle it and make a living out of it"

P14RDE: "Luckily for us, because we offer a bit of a financial reimbursement for the electronic waste, we try to do our best to keep everything off the roads. Once again, having your OEM's and your manufacturers participate and get more involved in community upliftment, and generate an income, and generate employment, you know..."

P14RDE: "So this would be a unique investment for them to get your, let's say your old and redundant six meter, twelve meter containers, convert them into working environment for these guys, and say we want to stimulate a GDP for you, a gross domestic profit for the country, generates an income, generate a source for you, and then also put our branding up on these containers, but at the end of the day, have these guys from your formal settlements, from your rural areas get together, bring everything together, and then start taking apart disassembling and stripping and educating people, training them, creating employment, and creating a steady source of income, because these, once again, as I've said in the first question you asked me, education, nobody, you know, people aren't educated about electronic waste."

P17RDE: "Collection initiatives in rural areas are a major problem. We have addressed the problem by placing containers in rural areas where the community can take their e-waste and get some money for it. At the same point internet connections can be accessed at the containers, CV's can be printed etc. Refurbished laptop can also be ordered from these points and will be delivered to the purchaser. The whole purpose is thus to attract people to have a reason to go the containers."

6.6.5-E-waste separation stages

-Importance of separating e-waste at source

P1ES: "...so people hang on to stuff because they spent a lot of money on it, and the reality is is that it's worth nothing, it's worth nothing in their hands, but if it goes through a proper system the value can then be unpacked. We're going to try and educate people of the fact that they need to do the responsible thing, I mean for every single individual to try and recycle their own computer or whatever, they're not going to make any money out of it, but a sole separation program needs to be tagged with a different component as well."

P1ES: "Well, it's got to be conducted [Referring to separation] close to the source of where the stuff is coming from, because logistics kills everything."

P2ES: "So separation at source, not just for e-waste, but for all waste streams, needs to start at home"

P2ES: "So people need... a program needs to be put in place for that awareness to be made, and for the incentive for people to start separating at source. Why? Because as we all know, landfills are a big issue, and I'm not going to get into that now, there might be a question around that later on, but if you start separating at source, everybody benefits"

P2ES: "Yes, so small items can be disposed of, like say, you can have a red bag or something where you put small e-waste in, and it's easily identified when the guys come and collect the stuff they just pick up the red bag and that goes in a separate container, separate trailer, or whatever compartment, so that can be handled quite easily, because the small household items is potentially the biggest problem, because they get dumped and that lands at landfills with all the heavy metals, and they get exposed to the elements, it creates all the contamination."

P3ES: "Okay, ideally obviously there needs to be some separation at source, because if you throw together some old computers with some CFL's, you know, you will just break those lamps, you will release the mercury, so basic protection and separation needs to have, on a household level"

P3ES: "So I would say, whilst the households need to take the basic precautions of avoiding any breakage or spillage, okay, it would have to happen on those drop off sites that the municipality runs. It would have to happen on any mass collection points at a shopping mall or something, that you have someone that is actually there typically employed, with the knowledge to separate those streams."

P3ES: "In basic groups, ja, and you know, that's the thing, not to go into too much detail, but to actually take cognisance of what are chemically and physically comparable streams. You don't want to put things together that are potentially explosive, and you know, you would need quite an expert, someone that ... you cannot just take a dummy from the street, those are people that takes responsibility."

P4ES: "...as soon as it touches the curb, it now becomes the local municipality's responsibility, and unfortunately their mandate is for disposal, and the municipal systems act they're responsibility is for disposal, and unfortunately in South Africa we don't have the right sort of resources to check through everyone's waste, and so essentially it just gets thrown away, unless it's been separated into a proper system"

P4ES: "Whereas what a lot of guys do is, they will just take and collect a whole bunch of electronic waste, put it into a container and then either ship it to China or Germany, or what not....and so, that's just easier to do that, they'll be out of a lot of money, but it doesn't matter, because it was a lot easier. So ja, maybe doing it this way is also a great opportunity"

P4ES: "And I think if you didn't do it this way where you had a hub where it was been separated correctly, what you might find is that ... because separation increases the value of something a lot, because now you can have a modules amount of one type of waste stream."

P5GA: "...so when we license all the material recovery facilities and their drop off facilities and transfer facilities, we force them to make provision, to take this waste [Referring to e-waste] types out. So, it will not be a thing that you put into your normal waste stream, it will be a special waste that you'll have to take to your drop off, or your transfer station or your material recovery facility"

P5GA: "...the moment you start working on that thing, and start separating, or you're taking the motherboard out, it becomes a waste less activity, and it becomes a hazardous waste authorization that you have..."

P5GA: "You see, this is a very wide waste type. What I'm trying to say is, it's a different system of handling IT and PC's and stuff like that, than to handle fridges and household appliances...."

P9GA: "My opinion is that, as a consumer, we should be separating the waste, because of the nature of the waste, the fact that it's toxic, and not put it in the same bag as the rest of, you know, the domestic waste, or municipal waste, but I also know that that depends on the availability of appropriate receptacles"

P14RDE: "For your home owners, like in overseas they have a program whereby people actually have different sort of bins, one bin for your glass, one bin for your paper, one for your foods, and then now they've actually put in one for your electronic waste. Something like that should be implemented in South Africa as well, so that when you have a reputable electronic waste recycler come by, you can say oh, hold on, the red bag is full electronic waste, only pick up the red bag, the green bag is for the normal waste, the yellow for this, and for such, and for such."

P15RDE: "You'll have to have a general box or bin or whatever, to put the stuff in...and the separation will have to come after that." P16RDE: "Ja, because we encourage obviously people to try and separate it, it's source and household, but not everyone does"

P19SCM: "I think at separation at source it's good, it fits with the economics, at least in terms of the separation, and I think within paper and packaging they also try and encourage the consumer, you know, to do separation at source, at home,"

-Minimised e-waste streams must be separated by knowledgeable persons

P3ES: "So I would say, whilst the households need to take the basic precautions of avoiding any breakage or spillage, okay, it would have to happen on those drop off sites that the municipality runs. It would have to happen on any mass collection points at a shopping mall or something, that you have someone that is actually there typically employed, with the knowledge to separate those streams."

P3ES: "[e-Waste must be separated] In basic groups, ja, and you know, that's the thing, not to go into too much detail, but to actually take cognisance of what are chemically and physically comparable streams. You don't want to put things together that are potentially explosive, and you know, you would need quite an expert, someone that ... you cannot just take a dummy from the street, those are people that takes responsibility."

P4ES: "The reality is, when it comes to the public, it really can't be up to the public, because all you need is one person to make one mistake, and it stuffs the whole system up. So realistically it cannot be the public who is in charge of separating, it has to be some other mediator, or an immediate organisation, so that would probably be your aggregators"

P4ES: "I don't know if "Person X" would have spoken to you about the new ISO principles, ... essentially illustrate or provide a sort of best practice for how you should be handling secondary metals, including electronic waste, and so it's about having the right masks, having the right handles, it's all the ... you know, health and safety. So those points you can have health and safety that can go and sift through what needs to be taken out, so you dismantle it, because they've got the right machinery to actually break apart"

P9GA: "So it's a way to go, but you cannot collect it separately. So you can't have someone coming to collect only batteries."

P9GA: "The person who's collecting it for recycling, the recycler, the person who's going to recycle it, can separate it into different components, or different waste streams, or categories of e-waste...because they will then know what best to do with it once they've separated them"

P12GA: "...the way I see it is, if I look at the value chain, the municipality starts with the waste, and we are trying to provide access to the middlemen, which are the sorters, which obviously need to be accredited or you know, like regulated somehow, which we do do, but in my opinion, those guys need to work with the market forces to do the sorting, and where the market forces don't cover them, for example, things like CRT screens and the items that don't have value, that is where an EPR system would come in and subsidise that market, but I still see it as the responsibility of those middlemen to do the sorting, because it's in their best interest in that business to sort. They want to get best prices, so sorting makes sense for them to get the best prices, just the same as any other recycling stream, similar. Obviously it's got differences, but it's got kind of a similar principle."

P16RDE: "So obviously the next person he collects it to being a tier four person, base four collector, ja, they're definitely going to be a part of the structure to recycle to one level, and then from that level then they'll go to more in depth then with some more technical specialists at tier three or tier two, focusing on that little separator again or grade it according to what it needs to be."

P19SCM: "First of all, I would not agree with separation. I think we're already making a big mistake by separating e-waste from other waste streams. We're already making a mistake if we separate e-waste from paper and packaging. If we separate it from collect a can, the glass company, we're already making a fundamental mistake at the collection stage, waste is waste."

P19SCM: "I do not believe within e-waste we should be separating it, I think as best as possible, we need to try and keep it as a topic"

P19SCM: "And then, if you need now start with education on awareness, you cannot take a toaster to that point, and you can maybe take a washing machine there, it's just going to be very difficult for the household."

P19SCM: "So in terms of separation, at least if we need to treat the different waste streams separately, all e-waste, if it's a collection point, or if it's just a drop off point at a retailer, you know need to accept all e-waste, you know"

P19SCM: "When we look at the value chain, we need to make sure that separation, already at separation we need to apply controls, very strict controls, because the equipment might not be whole, it might not be in its original form."

6.8-Theme 2-Transportation of e-waste

6.8.1-Transport problems and responsibilities

-Transport is an obstacle to recycling e-waste

P1ES: "...was an issue around that EPR was specifically targeted around covering the logistics costs of tire movement. EPR again in terms of e-waste, would again be largely recovering those transportation costs. So who pays them? That's a difficult one."

P2ES: "I'm sure everybody would have told you that the transport leg, in any reverse economic situation, is the single biggest cost factor. So you've got to get that done. You've got to mitigate that down to the lowest possible cost factor, and one of the ways to do that is to reduce the bulk, not the weight, but to reduce the bulk."

P3ES: "importing Apple products into South Africa, they, as a mass distributor, sends stuff to the suppliers, none of those trucks needs a hazardous waste licence, it's just a normal transportation of goods, you know, but the moment electronics becomes waste, it's classified as hazardous waste, and then you're really becoming very sticky, and you know, we're not transporting around a hundred kilograms of asbestos, we're transporting around a hundred kilograms of e-waste. So worst case scenario, that truck falls over, what is actually the actual risk of contamination?"

P3ES: "...with the government that do understand that they try to protect the environment, but they totally overregulate, because the waste license requirements listed activity acquired, are not really linked to the actual expectable risk, and especially with transportation, it is ridiculous. I think minimum requirements, of course, it needs to be a roadworthy vehicle, it should be an enclosed vehicle, but that's pretty much what I think would be required for electronic waste."

P3ES: "When you look into the rural environment, you obviously have a big problem that you have transport. So you wanted to create satellite stations, that's quite important, again, also the ... utilising rivers logistic will become more and more important, so you need to rope in the suppliers of electronic goods, you know, if those stores are equipped, you know, that should be then utilised as additional support in terms of transportation, to get it back to a major hub."

P3ES: "...well perhaps, but that would be things like transformers, but for household electronics, coming from a household source, there is nothing I could think of that is actually warranting this. I mean, we know that there are problems with radioactive elements, and smoke detectors and things like this, but let's say for ICT equipment, we narrow it down just to the run of the mill ICT equipment, you can just take any truck that is enclosed and is roadworthy"

P9GA: "And not everyone has a bakkie to take it and drop it off. That could be possible if you do have transport to take it yourself, otherwise there should be a system where you can call, and they come and pick it up, but it always comes at a cost"

P10GA: "You know what, the issue of transport is a bit tricky, because transport is costly. If I say, let me say I'm a buyer of e-waste and you are an entrepreneur, if you bring that e-waste to me you're going to incur cost. If I come and collect it from you, still I'm going to incur a cost and I'm going to end up paying less, because I'm going to subtract the money for that transport that I travelled to collect that material."

P10GA: "That's just my thinking, but I know transport is a big issue, and most of the people cannot recycle, because they don't have transport, and I cannot travel all the way from here to Pretoria to collect two TV's"

P10GA: "...but with the big appliance it's very tricky, and remember also, with Pikitup, Pikitup introduced a system to say the bulk waste should go to...whether it's a mattress, whether it's a couch, whether it's a fridge or it's what, it should go to the nearest garden site and then maybe somebody can come to the garden site and reclaim it, but remember, not everybody got transport, or not everybody knows about that services."

P10GA: "And if we say the entrepreneur must provide transport, how many entrepreneurs are able to provide transport, and e-waste, remember, is not something that we can take with a sedan car or whatever, you'll need a bakkie or you'll need a small truck."

P12GA: "Ja, I think the other challenge is that, as municipalities, we have a certain type of waste vehicle, which is really specifically designed for household waste. So we would basically need to purchase a whole other fleet of vehicles, so it's a whole massive capital expenditure, plus operational expenditure of doing the collections. So the question is, I mean, we can do it, but who would pay? You know, and then we'd have to raise our tariffs and nobody..."

P15RDE: "Because otherwise, you know, if our washing machine packs up and the maintenance guy must come here, because we can't move it, we haven't got the facilities, so you must get a little bakkie, and it's a collection bakkie."

P16RDE: "The question I would ask that one was about the transportation and the centralising of it, because that is the problem with any recycling, its grading it, and obviously transporting it."

P19SCM: "Transport for e-waste can be very expensive, especially if there's no, let's say maybe a light knock down of the equipment, because it's all about volume, and if you talk about e-waste categories, I mean, if it's not knock down or semi dismantled, it takes quite a bit of space. So it's quite expensive."

P20SCM: "But something like that could work, again, logistics, you know, if you say in Gauteng, you know the distances could still be, let's say they gave a R100.00 or R200.00 for an appliance, are you going to transport that 100km?"

-Parties responsible for transporting e-waste

P3ES: "You see, the idea of the EPR money, if you look at that Extender Producer Responsibility levy, the idea is that it pays for the non-viable fraction of electronic waste, and also the non-viable treatment steps of electronic waste, so to speak. So if transport is a cost, of course it is a cost, what else could it be? You know, it would create a non-viable situation, and that needs to be factored in, with regards to the overall calculation of what's viable, so the industry, rightly so, should not be taken to task to pay for the recycler of printed circuit boards, because that happens already, but we know what the critical hazardous fractions are, and the transportation of the hazardous, critical, non-viable fractions needs to be subsidised with the EPR levy. So strictly speaking, if something is now already transported from Cape Town to Johannesburg to Desco, because there is a value proposition like for example, for a printed circuit board, I don't think that there should be anyone paying for that. This should be paid by the private sector that is benefitting from the recyclings"

P4ES: "...then it has to be at the cost of the recycler or the ...Ja, because they [Referring to recyclers] find value in it, and they have to therefore pay, and that's why their system works, because there's a supply and demand, if there's a supply and you want it, you have to pay for it"

P4ES: "I think the corporate entity has to stand up to the plate and make some sort of payment. The problem is that they just carry that over to the consumer, and then pays for it, but I can almost guarantee that the consumer would never pay for it, because they're getting free municipal collections, 15 and we don't have the right facilities to monitor everyone's waste. So the reality is that it can't be the consumer who pays for this, it essentially has to be either ... It's interesting, because if you have the warehouse situation, it can't be a private sector, it has to be the PRO to make sure that everything gets there. [On Researcher Question: "Who should be responsible for that payment of the transport?"]

P5GA: "So, I want to bring it back to the producer of it, because you produce it, you've got a lot of money for it, I think so you have to put something in place to make sure that will fund the whole logistics of getting this thing back and not, if it has to go to a landfill or a treating facility, that will be paid out of that fund."

P9GA: "we can have somebody else collecting it, and when that person collects it, they can take it to a central point where it gets collected by the recycler, but eventually you must remember that a recycler is going to get this thing [meaning e-waste], and usually they buy it."

P9GA: "They make money out of it. That's why, in most cases, they're even willing to come and collect, depending on the quantity, but otherwise, even the collector who collects from different areas, they know that we are going to sell it to the recycler who's going to pay them for it."

P10GA: "So at the moment I will say maybe the buyer should be responsible for the transport, but maybe they should look for funding that can assist them to meet the entrepreneur halfway, because if they're going to charge the entrepreneur, obviously the entrepreneur is not going to make money."

P14RDE: "I will say the onus should fall on the recycler themselves, reason being for those, like with us, we've got our own fleet of vehicles,"

P14RDE: "So we [as recyclers] can manage what's collected, we can see what's been collected, and we know exactly what we're collecting."

P14RDE: "would say that onus, that responsibility should fall on the recycler that's going to the central point, as you've said, they've bid for the goods, they won the bid, and they bought them, they've paid for them, the onus should solely be on them to go and collect it from there and then bring it back to their plants."

P14RDE: "That transport, I think, should be the responsibility of the people hosting the auction."

P14RDE: "That would solely be, because the reason for that is, they [Referring to an auction house setup] fraction in their costs with whatever they are going to be selling off at the end of the day. So they can say they're starting off, bid will be x amount, because they flushed in their cost. I think, and as I said, you know you can't expect an institute like that to just run on its own, they have to make the money somehow. So I think the responsibility would be on them from collecting, to dropping off at their site, and from thereon then selling and re-distributing"

P15RDE: "To the auction house ... you see, all of this is uncomfortable stuff, grudge, if you know what I mean. So if the auction house wants it, it must go and fetch it."

P15RDE: "I think that the recycler must come and fetch it."

P18RDE: "...they're not included in that same contract, and like for instance, if we have the Game and the Pick 'n Pay, we will take it from them, so it depends on who's got the contract. That person will transport. If it's big enough volume that comes from that site, then we can get the actual recycler involved who will collect it from and on our behalf from that store then, but in most cases we take it and then take it to them."

P18RDE: "Straight, from the shopping centre to the recycler it will be the recycler's problem, and even if it goes to our site, it will still be the recycler's problem,"

P19SCM: "...and the recyclers are good at what they do, and they should be allowed to also do quite a bit more than just separating the material. You know, they should be able to conduct their transport"

P19SCM: "That should be left in the hands of the industry [Referring to recycling industry]. The industry is good at running the business, good at collecting, good at streamlining logistics....it definitely should not be tendered out, you know, to just transporters. It's definitely to the front end to that collective, that collection network, and ultimately to those who will be separating it, and that can make that informed decision, you know, to say whether it can be reused, or whether, you know, it needs to be further processed or further value needs to be added to the material."

6.10 Theme 3-Extended Producer Responsibility (EPR)

6.10.1-Responsible parties for e-waste management

-Extended Producer Responsibility in e-waste management

P1ES: "That's where an Extender Producer Responsibility component would become very useful, if one can look at it price per kilogram, you could go out and say right, your computer plus the screen and monotonal rest of it, or the desktop, is on average 27 kg, we're looking at R3 a kilogram for that product, we will pay you x amount for that weight."

P1ES: "A reward system. So the issue around the extended producer responsibility thing is something which makes sense to me, because then your importer, retailer, your OEM or whatever, would then already include a cost into the system, which they could then pay back. So it would have to be linked to an EPR type of system. If you look at the recyclers, some of them are looking at it for a reward perspective where, if you look at the likes of "Recycler A" is a large company, a huge amount of their waste is coming in from the informal collectors who are paid R2.00 to R3.00 a kilogram for what they're bringing in"

P4ES: "I think this does lead on to your ... the next section, but essentially it has to be an EPR system, and I think the public do need to feel the cost of it somehow, but also the manufacturers, because what you start finding is that the manufacturers are the ones producing sub-car machinery and technology depth of using, you know, poor batteries that only lasts a couple of weeks, you should suffer for the poor quality of the product that you're making. So ja, I definitely think it should predominantly be the manufacturers and the consumer needs to also ... the consumer does need to feel the cost of it, but I don't know how they would, I don't know how you could tell the consumer to pay, unless it comes in the product, ja"

P4ES: "Sho, I think ja ... I think we'll obviously fight this with this sort of the EPR for general waste as well, it's hard because people often say the consumer is responsible for it, but I often think consumers get tricked into purchasing things and not understanding things, and I often think that, and this is a personal perspective, is that I often think that the corporate entity often misleads the consumer, so I definitely think the ... I think the corporate entity has to stand up to the plate and make some sort of payment."

P5GA: "This is a very important point, is that the disposal thereof is over, and above the tariff that you pay, and it's very expensive to dispose of these things, and there's specialized facilities taking care of, so strictly speaking, if you're putting it to the municipality, that's basically not fair to give it to the municipality, and they have to carry this cost, I think the thing they should have here is the extended producer responsibility that should be implemented with the industry waste management plan, it means when you purchase it, you already paid for the responsibility [Of recycling] of it."

P9GA: "Yes, I think it's about time, that's what other countries have been doing for many, many years [Referring to EPR], and as a result it's managing this waste very well. You don't see it, people see..., you don't see it lying around, and it doesn't end up in the landfill sites, you know. So it's a way to go, but you cannot collect it separately. So you can't have someone coming to collect only batteries."

P9GA: "EPR, you know, it's the responsibility of the manufacturer, so they drive it, they ensure the funding thereof, and who should run it, so they basically set up the whole thing. I mean, the model said, I know of from other countries, that's how it's done and it's been running successfully for years, and I think we should try and do the same. We should have manufacturers establishing an entity that would ensure the funds are distributed and that it complies with whatever government says it should do."

P10GA: "You know what, I think there should be sort of a levy where all these people they pay in, so that when this thing goes back to Makro and whenever, because those LG's, you can't take it back to overseas or where you've got it, but those people they should be able to pay a certain levy into an organisation, so that that levy can assist whoever the recyclers or the people that are doing the e-waste recycling in terms of the facility, you know, managing the transport, all the systems, but there should be an organisation where all of them they subscribe to it and they pay the levy."

P12GA: "... the way I see it is, if I look at the value chain, the municipality starts with the waste, and we are trying to provide access to the middlemen, which are the sorters, which obviously need to be accredited or you know, like regulated somehow, which we do do, but in my opinion, those guys need to work with the market forces to do the sorting, and where the market forces don't cover them, for example, things like CRT screens and the items that don't have value, that is where an EPR system would come in and subsidise that market, ..."

P12GA: "Ja, I've just seen that working in the packaging industry where the ... because the product responsibility organisation is getting levies, and part of their mandate for that money is to invest in markets, and invest in recycling facilities, to provide a demand for that material, and then that material becomes recycled a lot more, because there's a market for it within the country."

P19SCM: "So an EPR mechanism should be very dynamic, it shouldn't just be labelled as a take back program, it should be seen as a mechanism, it should be seen as a mechanism to address the current shortfalls within the economics of what you're trying to do."

P19SCM: “Ja, so that producer responsibility starts way early in, let’s call it EEE, Electrical and Electronic Equipment’s lifecycle....Extender Producer Responsibility is all about producing a placing on the market, a product that will contribute to the sustainable nature, in terms of the environment, and in terms of health”

P19SCM: “And that can be anything in terms of materials, in terms of, let’s say, any consumption, natural resources, but ultimately extender producer responsibility is a mechanism that is used, let’s say, to address a specific issue, or a specific problem. At this point in time we see that the governments have clearly identified it, and the governments have also clearly identified as a way of somehow shifting the responsibility. Shifting the responsibility, you know, to industry on the one end, and then potentially, you know, creating an additional tax that could then also assist government in terms of doing many other things, but I think that’s the big problem, you know, where we see that EPR is being seen in a very short sighted way, you know, in terms of what it can actually bring to a country in terms of putting safe and sustainable products, importing, or manufacturing safe and sustainable products, you know, for your country. So I think a very short sightedness, a very narrow view in terms of EPR, and in terms of the narrow view, the big problem is the different methods, the different methodologies around EPR, and the interpretation thereof.”

P19SCM: “So I think it needs to be seen in the correct light [Referring to EPR], you know, specific to a country, to the economy, and the needs in terms of addressing the problem.”

P19SCM: “It [Referring to EPR] should be obligation based. If we say it’s fair, it’s a level playing field, then it would be clear that not all producers would share the same level of responsibility. It should be well aligned to the product, the needs of the product, becoming a waste stream, recycling costs, responsible ESM, (Environmentally Sound Management) of e-waste is different from category to category...”

P19SCM: “We need to change that behaviour, and that’s why we believe that cost should be borne by the producer, in a fair way, “IT producer X” shouldn’t be paying the same as what a “IT producer Y” is paying, or “IT producer Z”, or let’s say what “White goods produce K” is paying or “White goods produce L” would be paying. We rather want to see that built into the lifecycle in terms of entrenched sustainability.”

-The intersecting roles and responsibilities regarding e-waste

P1ES: “Well there should be a responsibility at the consumer level. Unfortunately there’s not enough information and education awareness out there with regards to their responsibility. Very few people in households understand the negative components of e-waste, and if they’re not handled properly how they end up in the wrong place, so we end up with e-waste going to landfills.”

P1ES: “...so people hang on to stuff because they spent a lot of money on it, and the reality is that it’s worth nothing, it’s worth nothing in their hands, but if it goes through a proper system the value can then be unpacked. We’re going to try and educate people of the fact that they need to do the responsible thing, I mean for every single individual to try and recycle their own computer or whatever, they’re not going to make any money out of it, but a sole separation program needs to be tagged with a different component as well.”

P2ES: "So there has to be joined responsibility taken by all participants in the value chain, so as I've just described, the OEM as distributors must take some responsibility, the retailers as such must take some responsibility, and then obviously the consumer must also take responsibility."

P2ES: "The consumers' responsibility must be that they must be made aware of what the potential hazards are around having the e-waste and disposing of it in an irresponsible manner, but then the system via the producers, must provide a mechanism whereby waste can be disposed of conveniently, safely at no cost to the consumers."

P3ES: "Okay, the responsibility of the household consumers would be to take back where it has been bought. So I think that is a responsibility that should be legally enshrined, like for the retailer, the responsibility is to accept the take back, it should be a legal responsibility for the household to bring back. So the responsibility I would assign as to any household is to bring back, and that should be legally requested."

P3ES: "Okay, the responsibility of the household consumers would be to take back where it has been bought. So I think that is a responsibility that should be legally enshrined, like for the retailer, the responsibility is to accept the take back, it should be a legal responsibility for the household to bring back. So the responsibility I would assign as to any household is to bring back, and that should be legally requested. "

P4ES: "...technically electronic waste is classified as hazardous waste, and so the responsibility of the consumer is not to actually dispose of it as general waste, but often what happens is, the consumer doesn't know, but unfortunately in law, you cannot claim ignorance. So personally, and I guess in general, is that the responsibility does fall onto the consumer. But two things happen, the consumer doesn't know, and secondly they don't know where to drop it off, they don't understand the details and intricacies of e-waste disposal. So ja, I think it's definitely the household responsibility to dispose of their specific e-waste correctly, but at the same time I also think that it is the producer's responsibility to make people aware of the fact that their product has the potential to damage the environment and that it should be handled with care"

P7GA: "I think generally in waste, government and the producers need to re-establish their relationship with the consumer. There's been a lot of mistrust. You've got the plastic levies, you've got the tires, you've got this, you've got that, if you want the purchaser and the consumer to be part of anything, there needs to be a trust rebuilding."

P9GA: "My opinion is that, as a consumer, we should be separating the waste, because of the nature of the waste, the fact that it's toxic, and not put it in the same bag as the rest of, you know, the domestic waste, or municipal waste, but I also know that that depends on the availability of appropriate receptacles"

P9GA: "But still, that responsibility [Referring to separation of e-waste from other waste] lies with me (the consumer), no one is going to come into my house and do that for me."

P9GA: "The money should come from the same people who are producing the products, I mean, we ... the question is that why is this now a problem? Yes, it's convenient for me, but it's a problem, because you manufacture it, and in your manufacturing you should have factored in that at some point I'm going to have to throw it away, or recycle it, or whatever, you know, and you get a phone like this one, and it says don't throw it in the dustbin, where must I take it? What are you providing for me, you know, to ... are you going to come and collect it? Are you going to tell me where I must take it, if you say I must not throw it in the dustbin? If in my country, my village, wherever I come from, that's the only method that I know, you understand, so when I buy it, you must already have a plan on what I must do with it, you must inform me. So the money would definitely have to come from the manufacturers themselves, they must provide the system of collection, including the funding thereof."

P10GA: "Okay, with my opinion, I think as a household, or as a consumer, we should be responsible for the waste that we generate, and then I think the household should look for other means to dispose, or to reuse, or to recycle the waste, they shouldn't just throw it in a bin. I think education is very, very important to our household, so that ... because the household will definitely discard the e-waste after they've used it, because they don't have an idea, they don't know what's happening, they don't know where to take it. You know, education and awareness, I think it plays a very important (role) in our society, so that they can know what to do with the household, I mean with the e-waste. At the moment they will discuss it, because they don't know what to do with it,"

P10GA: "Sjo, that one is a bit tricky, because remember, it's got municipality which also have to play their role, and we also have the e-waste association, that they also have to play their role. We also have the polluter, or the manufacture, they also have to play their role. So at the moment, to be honest, I don't know who's supposed to be responsible, but I think all of us we have to be responsible to make sure that e-waste doesn't land wherever it's supposed to land."

P10GA: "You know what, I think those stores they should be made responsible for the waste that they generate, maybe let's have the bins, like I've seen this nowadays, most of the shops, Makro and whatever, they have the bins where people can go and drop those recyclables so it should be from the industry be imposed, not imposed, but regulated, one way or the other, to force the retailers to take responsibility on the waste that they sell to the community. Have bins, have service providers that are coming to collect those recyclables, that e-waste recyclables."

P11GA: "...as a household, or as an individual, and you are supposed to take your ... anything related to e-waste, to such a site, and that is the responsible way we encourage people, and the infrastructure we provide, to encourage responsible disposal of e-waste. So I don't think we will encourage them to leave it on the curb side, or in our wheelie bins system"

P12GA: "Okay, in my opinion, I think that householders should be responsible to manage that waste in a responsible manner, within the environment that is available to them at the time."

P12GA: "...so if there is a recycling option available to them, where they are situated, they should use it, otherwise safe and responsible disposal. If there's a take back system, they should use it, ja, so I think it is their responsibility to just protect the environment in how they manage that waste."

P12GA: "In other cases I think additional responsibility by the product manufacturers is needed, because that kind of recycling technologies should start being invested in in this country, we shouldn't be selling our circuit boards to China for recycling. I believe that is the responsibility of the manufacturers and the producers to be investing in that"

P14RDE: "...the home owner, or the consumer, at the end of the day, shouldn't be on this on his own, he should have the assistance of the people where he purchases the items from, to inform him as well. So if you want to get to dispose of your electronic waste, we would like to say to you, these are the people that you can contact, or please, do contact the responsible recycler to assist you with the recycling of your electronic waste"

P14RDE: "The people bringing in the problem, the people bringing in the materials, or bringing in the products that we are buying, I don't think we can solely put it on them. It has to be a 50/50 initiative whereby our government, your resellers, your manufacturers, your government as well as your re-sellers must come together and come up with a body, like a governing body, as you said in the past, and start taking the bull by the horns"

P14RDE: "...and start maybe working in conjunction, let's say going to universities and saying we've got bursaries available, this is what we'd like to offer you. You come up with a solution for us, a viable solution for the recycling of these materials, and we can start putting in tenders for your financial gains, or whatever, to assist you. In that way, once again, it's a win situation for everybody"

P14RDE: "I think everybody should be involved, from top tier government, right down to your manufacturers, your OEM's, your importers, your exporters, it all starts at the top, but preferably your sellers and your re-sellers should be made well aware of what the hazards are of electronic waste, as well as to educate the clients and say to them, this is what I'm selling to you, do note that you need to have a responsible recycler to take care of your electronic waste for you."

P14RDE: "So once again the onus and the responsibility should land on the supplier, or the re-seller, or the OEM and the manufacturer, to make from manufacturer, to re-seller, from re-seller to client end user, to make them aware of this is what you have, this is the manner it should be disposed of."

P14RDE: "I feel they [Referring to producers] should be held accountable for all the goods that are being dumped on the side of the road, it is their electronic waste at the end of the day, and they should be held accountable, and they should have these little recycling ventures all over the whole of South Africa, they should have little recycling ventures with little skips or little bins where people can bring their electronic waste to, and a bit of money for themselves."

P14RDE: "I foresee it [referring to a take back program], yes, and I think the government should be in on this, once again, but as I always keep on reiterating, it should be your manufacturers and your suppliers, they should become more....they should invest, they should become more attentive and start doing more for there."

P14RDE: "...the home owner, or the consumer, at the end of the day, shouldn't be on this on his own, he should have the assistance of the people where he purchases the items from, to inform him as well. So if you want to get to dispose of your electronic waste, we would like to say to you, these are the people that you can contact, or please, do contact the responsible recycler to assist you with the recycling of your electronic waste"

P16RDE: "Ja, definitely your outlets where you purchase the stuff, because that's the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you're buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what's ... ja."

P16RDE: "A little reverse logistics. So when someone delivers the fridge, they must take the fridge back out, and like a battery component, lead acid batteries has got something very specific like that when they pay there, I think your deposit system is like R150 and that works really well, so ja."

P16RDE: "Ja, definitely your outlets where you purchase the stuff, because that's the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you're buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what's ... ja."

P19SCM: "So, in terms of responsibility, it should be the responsibility of the consumer, because we first need to look at the consumer, and what is the rights of the consumer. The consumer will be the legal owner of the product, and very important that that decision, in terms of the disposal, or in terms of a different use then lies legally, you know, with that consumer, with that household, they should be able to make a decision, and in making that decision, a number of factors would come to mind."

P19SCM: "I think from a selling point of view, and I think that's where the education starts, it's quite advanced in the lifecycle, and it will definitely help in terms of the informed decision then that needs to be made by the end user, by the consumer later on."

P14RDE: "My honest opinion, the consumer, or the household owner, or the household person should know, they should be educated and know what the hazards are of household electronic waste, like what goes inside your fridge, what sort of gasses are inside your fridge, or your ... what sort of materials are inside your monitors, or any hazardous, or non-hazardous electronic waste that you dispose of."

P20SCM: "Ja, ja, but you need to prompt the question to the end user and say, when you sell a product, you're saying well, what's happening with your old product."

6.10.2-Creating legislation and awareness on e-waste

-Legislation required to encourage the development of an e-waste system

P1ES: "So from that perspective there almost needs to be a government intervention in terms of making sure that hazardous material is not getting in to landfill. At the moment, most your CRT's are ending up in your hazardous landfill sites, which costs a fortune, which is why there's so much illegal dumping of CRT's."

P1ES: "...the only thing hazardous about a computer, or anything else like that, is if you drop it on your toe."

P2ES: "They said well, fantastic. I said great, so let's sign the agreement. No, we can't do that because the legislation doesn't allow us and the public finance management act has got too many complications. So that's a challenge. Municipalities, by law, have to provide a service to consumers to collect and treat their waste. But I think we have to now realise time has changed whereby we can't just say yes, that's the law, then we leave it to themselves, because it's not going to happen. Not necessarily because they don't want to do it, but because often they don't know how to do it."

P3ES: "It's totally unacceptable, because it gets out of control, so this is not acceptable, people putting things on the curb side, it should be a legal offense, it should be punishable, it should be prohibited, because we know that most of the worse practice taking place in South Africa, people burning cables, smashing equipment, that comes from this type of complete uncontrolled release of electronic equipment, waste electronic equipment into the environment."

P5GA: "So, I really think there should be a special dispensation, just for e-waste, because it's a different thing. It's not like it's acid, and I pour acid on my finger and it's going to disappear. I'm going to take this cellphone and now it's very nice and sexy, but the moment there comes out a new one, it's become waste to me, and it's not the impact on the environment. So, I definitely believe that we in South Africa should not, we should rather go to the toxicology of the hazardous waste types and classify there, but definitely I think it's such a specialized waste type, you need a different dispensation for e-waste."

P5GA: "...but don't give e-waste in general, this hazardous waste label, it makes it very difficult, because initially, even the storage had to have trigger waste licenses."

P9GA: "It's very unfortunate, unfortunately the very same companies who are proactively doing certain things in those countries, when they are in our countries in Africa they don't want to do the same thing, so there's always double standards. And the other thing is, because our legislation probably allows them to get away with it."

P11GA: "The ideal situation would be for there to be legislation that says, if you have a broken fridge or a broken computer, or a broken whatever, then you have to take it to your local drop-off site."

P11GA: "Exactly, we can't do anything that doesn't come from a higher up legislation. We can't even enforce household recycling of plastic material, it must be...legislated."

P14RDE: "So you need to have a ... into the National Environmental Waste Act, that we would have to implement a new law and a new bylaw to facilitate these PRO's, and to make them aware of, if you transgress, this is what will happen. So you need to have your ducks in a row, so that you can offload and function fully as a PRO..."

P14RDE: "The other slight problem that you do have, is you do have your Consumer Protection Act, The POPI Act, as well as your Second Hands Good Act, which compels a lot of people to hold on to the items for seven days, they call it a cool down period, all your old computers, things like that, old computers, because 99% of your fraud these days are committed electronically. So that also is a bit of a spanner in the works, so that needs to be incorporated into the whole system as well."

P15RDE: "I'll take you outside just now and go and show you what we're doing here for recycling, and the trouble you have to get people to actually participate in a controlled manner. The only way you can do that, is to have an act and a law that says you've got to do it"

P16RDE: "So ja, I couldn't say a government operation should run it, but ja, it should be legislated in that there would be funds at ring-fenced for that specific thing that was collected, to make sure as a ... South Africa we... we're full of toxic stuff everywhere..."

P19SCM: "Once again we should see how we can integrate and how we can work with the consumer, and then rather tell the consumer you can't do this, and we're going to fine you if you do this, you know. So that would be a no-go. So number one, the method needs to be convenient."

-Need for education on e-waste

P1ES: "Well there should be a responsibility at the consumer level. Unfortunately there's not enough information and education awareness out there with regards to their responsibility. Very view people in households understand the negative components of e-waste, and if they're not handled properly how they end up in the wrong place, so we end up with e-waste going to landfills."

P1ES: "I've done a number of investigations within my own family and friend network, where just about every single one that I know of, literally puts those CFL bulbs into the black bin. So we're ending up with mercury and phosphate and all sorts of other issues landing up in our landfill sites. So there needs to be a level of education, but there needs to be a level of ... without that education you're not going to get compliance and responsibility coming from the households."

P1ES: "...here's also a perception that people putting it on the pavement, that the scavengers would come and take it, and then you end up with smashed components all over your driveway. So if it is done, it needs to be managed properly, it needs to be set for a specific date, people need to be educated, they need to understand why they're putting it out there, and they need to understand that there's no value in it for them."

P1ES: "...so people hang on to stuff because they spent a lot of money on it, and the reality is is that it's worth nothing, it's worth nothing in their hands, but if it goes through a proper system the value can then be unpacked. We're going to try and educate people of the fact that they need to do the responsible thing, I mean for every single individual to try and recycle their own computer or whatever, they're not going to make any money out of it, but a sole separation program needs to be tagged with a different component as well."

P1ES: "And that's also from a place of work perspective, can be driven, where it's a lot easier to look at your education and your awareness component. The problem that I face with that is that everybody's always saying 'what's in it for us'? So there's very few organisations who will say right, we're doing it because it's the right thing to do, we're going to collect this waste."

P1ES: "That not only relates to ICT waste, it also relates to white waste, so refrigerants, people don't understand the issue around refrigerants, they don't understand the issues around some of the problems with the insulators on the systems, and things like mercury from CFL lights, very few people understand that"

P1ES: "when you get into the more urban areas where there's a lot of white waste, we're starting to see from a community, from a consumer perspective, like the understanding of the cell phone and computer as e-waste. They still don't understand that their kettle is also e-waste, and that needs to get into a market where we can tie them with beneficiation as well, where we can unlock the value of that waste right there"

P2ES: "The consumers' responsibility must be that they must be made aware of what the potential hazards are around having the e-waste and disposing of it in an irresponsible manner, but then the system via the producers, must provide a mechanism whereby waste can be disposed of conveniently, safely at no cost to the consumers."

P2ES: "So people need ... a program needs to be put in place for that awareness to be made, and for the incentive for people to start separating at source. Why? Because as we all know, landfills are a big issue, and I'm not going to get into that now, there might be a question around that later on, but if you start separating at source, everybody benefits"

P2ES: "In the study that we've just completed with our partners, we did a survey of municipalities throughout South Africa, there is not one municipality who has got a manager in charge of waste, who has got a qualification, specific to waste, not one."

P2ES: "...we've put out a curriculum, a developed curriculum for waste, not just e-waste, so there's modules, you plug in and if you want to specialise in e-waste you pull in that module, and if you want to do more to waste, you want to do solid waste, you can just add them. So the first forty students have just started their process for PhD's, and we will then roll out B degrees, we will roll out diplomas, right down, all of them are SAQA accredited, right down to waste pickers, who will come in and do a one or two day course, get a certificate, and they can go away and they're all certified. So that's a process that we're launching in November this year."

P4ES: "...technically electronic waste is classified as hazardous waste, and so the responsibility of the consumer is not to actually dispose of it as general waste, but often what happens is, the consumer doesn't know, but unfortunately in law, you cannot claim ignorance. So personally, and I guess in general, is that the responsibility does fall onto the consumer. But two things happen, the consumer doesn't know, and secondly they don't know where to drop it off, they don't understand the details and intricacies of e-waste disposal. So ja, I think it's definitely the household responsibility to dispose of their specific e-waste correctly, but at the same time I also think that it is the producer's responsibility to make people aware of the fact that their product has the potential to damage the environment and that it should be handled with care"

P4ES: "I mean that ... not saying to just put a little sticker on the back [Referring to the back of the equipment package], but to actually have a campaign around making people aware, because I think that's the things, the issues about awareness, and not just with electronic waste, but with all waste. There's a massive ... well below par, because people know they can recycle, they just don't know how and where and who the right people are to speak to."

P4ES: "I think it should be a PRO, with a large emphasis on awareness, particularly around ... it has to be a psychological awareness, not just like traditional media, it has to be subliminal, it has to be by the right people, it can't have any political undertones to it, it has to purely be driven by a ... and a PRO should be industry driven, but that would come up just now."

P9GA: "And churches, all facilities that are accessible to everyone, and put the receptacles there, but of course we know with all of this, it takes a lot of education and awareness."

P9GA: "But if they're just doing it for the greater good of the environment, you know, it's still something that is up there, they don't see the direct link"

P9GA: "So like I said, you know, you need to do a lot of education and awareness for them to see that it's actually...the bigger picture is that it will benefit me, whether I see it immediately or not."

P10GA: "Okay, with my opinion, I think as a household, or as a consumer, we should be responsible for the waste that we generate, and then I think the household should look for other means to dispose, or to reuse, or to recycle the waste, they shouldn't just throw it in a bin. I think education is very, very important to our household, so that ... because the household will definitely discard the e-waste after they've used it, because they don't have an idea, they don't know what's happening, they don't know where to take it. You know, education and awareness, I think it plays a very important (role) in our society, so that they can know what to do with the household, I mean with the e-waste. At the moment they will discuss it, because they don't know what to do with it,"

P10GA: "So I think education is very, very important, before we can do anything, let us start educate our community, our consumers, so that they can know what to do with that electric waste."

P10GA: "So it's dangerous, because somebody may want to dismantle it, especially when you look at the waste figures, they would want to dismantle it so that they can extract certain components of the e-waste, but they don't know the danger of that. So it's very also critical, even the reclaimers, or the waste pickers, they should be taught about the e-waste, what are the danger of the e-waste, especially when they dismantle."

P10GA: "...to be honest, at the moment, because people they don't know, they just put, but you know, I think if we can have the facilities and community can be told, or be taught about those facilities, to know, if I've got an iron, I can just put it to this facility, whoever need that iron, if he's reasonable, can go and claim it in that facility for free of charge, or maybe for exchange of something, I don't know, but if we've got the facilities where we can take all this, and then they can be claimed from there, I think it will help a lot, unlike we take it to the landfill site, some of the things, and then they just sit 100 years on the landfill site, because they are non-biodegradable."

P10GA: "The dangers of the equipment, remember some of the waste they got the lead, they got the mercury, they've got other hazardous waste."

P14RDE: "My honest opinion, the consumer, or the household owner, or the household person should know, they should be educated and know what the hazards are of household electronic waste, like what goes inside your fridge, what sort of gasses are inside your fridge, or your ... what sort of materials are inside your monitors, or any hazardous, or non-hazardous electronic waste that you dispose of."

P14RDE: "So it should start with education of people, so that they know what is everything involved, what can we call, what materials are inside there, so that they know when they dispose of something, when they want to get rid of any household electronic waste, where should they take it to, what should be done with it."

P14RDE: "Old CRT monitors has got beryllium, cadmium, mercury, lead in it, so the consumer should know, this old TV that I've got, this cathode ray tube it's got all these hazardous materials, I can't break it, I can't dump it, I can't just throw it anywhere"

P14RDE: "I think everybody should be involved, from top tier government, right down to your manufacturers, your OEM's, your importers, your exporters, it all starts at the top, but preferably your sellers and your re-sellers should be made well aware of what the hazards are of electronic waste, as well as to educate the clients and say to them, this is what I'm selling to you, do note that you need to have a responsible recycler to take care of your electronic waste for you."

P14RDE: "So this would be a unique investment for them to get your, let's say your old and redundant six meter, twelve meter containers, convert them into working environment for these guys, and say we want to stimulate a GDP for you, a gross domestic profit for the country, generates an income, generate a source for you, and then also put our branding up on these containers, but at the end of the day, have these guys from your formal settlements, from your rural areas get together, bring everything together, and then start taking apart disassembling and stripping and educating people, training them, creating employment, and creating a steady source of income, because these, once again, as I've said in the first question you asked me, education, nobody, you know, people aren't educated about electronic waste."

P18RDE: “Ja, batteries, most people take it to the shopping mall, or just throws it in their waste. Domestically it just goes to waste, in the normal mixed waste, where your companies, there’s a lot of companies that will, for instance, again, when we are on site, we separate that and makes sure that it’s separated and gets discarded as hazardous waste, or as a battery, you do not put it in the rest of the waste, and you know, that’s why we are there, we make the clients know, or educate them in what can be and what can’t be going into your general waste.”

P19SCM: “Number one, in terms of potential danger of, you know, of the household equipment that they’re disposing of, and number two, probably from an economic point of view, the most important element would be that they do not understand that there’s possible value, you know, to make that differentiation”

P19SCM: “I think from a selling point of view, and I think that’s where the education starts, it’s quite advanced in the lifecycle, and it will definitely help in terms of the informed decision then that needs to be made by the end user, by the consumer later on”

P19SCM: “And that just quickly brings me back to your question in terms of ... if I would then say what is the best place to dispose of it, would typically be at a facility that could help you make an informed decision”

P19SCM: “If we make that informed decision, there’s a better likelihood that we could be passing on value to that household, to that end-user. Number one, if there’s potential for me to get a little bit of money for something, I’ll be more encouraged to take it outside of my garage, or where I’m stockpiling it.”

P19SCM: “And then, if you need now start with education on awareness, you cannot take a toaster to that point, and you can maybe take a washing machine there, it’s just going to be very difficult for the household.”

P19SCM: “But once again, with convenience come education awareness.”

P19SCM: “I do not believe the end user, or the household, is in a position to accurately determine whether this article should be discarded or disposed of, or could potentially be refurbished, or potential parts of it could be reuse...And I believe in not having a proper process step at that decision stage, is causing a lot of wastage, because you cannot compare scrap metal value to second hand value.”

P19SCM: “Get people to understand in terms of electrical and electronic equipment, that there could be value, even if it’s not working, very important, so that we can make an informed decision”

P19SCM: “You know, it should not involve inconvenience, you know, to make that decision, what do I do with it now, or I could maybe do xyz, but rather not. You know, maybe I would feel not safe, let’s say maybe go into my local municipal dumping site, or garden refuge site, you know, so we should empower the consumer, the household, to make an informed decision, and I think there and then really lies the problem, in terms of education, and in terms of the eco-system that’s not in place in South Africa. I think the biggest factor there for me is that households can’t make an informed decision, because they are not properly informed.”

P20SCM: "Well, the consumer itself should basically see the importance of the items being either recycled or discarded. If they don't see the interest in thinking green, then they don't care, and then they're not going to contribute at all."

P20SCM: "You might go to Makro or whatever, and say right, a new washing machine, okay that's fine. It's not like they say well, what are you going to do with your old one?"

P20SCM: "But I think it's still a possible mind-set that needs to change"

P20SCM: "Ja, ja, but you need to prompt the question to the end user and say, when you sell a product, you're saying well, what's happening with your old product."

6.10.3-EPR Funding

-Government as EPR-Recycling fund initiator

P1ES: "So the waste bureau, effectively what we're now talking about, is literally applying taxes right across the entire waste sector, whether you're in paper, plastics, cardboard, e-waste, construction waste, whatever it is, there would be a tax imposed upon you as an extended producer responsibility. The problem that we have with that is that tax goes through the receiver of revenue. The receiver of revenue would then work with national treasury to see what percentage of that, because they don't ring-fence the tax, it goes into the general coffers. So your recycling EPR would now potentially be looking at housing or social benefits, which is not what we need to look at. If we could ring-fence that, it would be a lot better, but at the moment now the treasury would determine how much of that we could then channel through to the waste bureau."

P1ES: "If we have a waste bureau that's established, it should be a waste bureau. The problem is, anything with government is going to be problematic to me and the industry and consumers and anybody else, you know, that's the way government works. So I don't know."

P3ES: "It should be people that are appointed as competent people through EPR money, so ultimately it should be the producer's right, since the producer is paying for this, to actually ring-fence that money, which I'm very much thinking that is at the key of this whole EPR as working, so EPR sounds great, but I think our government has greatly 'bustedised' the idea of what an EPR could look like, the whole idea that, you know, you call it a levy, it's supposed to go to treasury, for me it is a 'systemly veiled attempt to just obtain money, ill gotten money without transparent feedback and, you know, if the industry is lucky, they can get a small percentage, but that is just another way to raise taxes, and if it's like this, I'm digging in my heels right here and right there"

P3ES: "The industry need commitment from our government and this money is their money and they can actually spend that money for the intended purpose, and it doesn't look like this right now, it look like this is utilised again as piggy banking on all kind of other things that the government hasn't delivered on, including job creation. And yes, there is scope for job creation, but I think it's getting grossly overestimated, and I'm very worried that most of the EPR funds where there should be actually ring-fenced to the safe and responsible collection and treatment of e-waste, are now completely side-lined for completely other purposes of unspecified origin."

P4ES: "I'm hesitant to say government should handle it, and my understanding about government is that they're not going to control, they meant to facilitate. So I think making it mandatory for organisations in the sector to register to be part of the system, it's government's work"

P4ES: "The last thing I want to say was is if government does take over the reins of funding, and often what happens is the industry believes that government is using these EPR systems to gain more money into their coffers, and whether it's for their own personal sort of use, or if it's actually for the country, the problem is that it has to be ring-fenced, and if you want to make a system work correctly, you can't have inefficiencies of money leaving the system and not actually going into try and keep it alive."

P4ES: "... they shouldn't be making a profit or making money from things, but the problem is is that as soon as they control it, then it goes into the coffers and distributed beyond why you collected the money."

P5GA: "It [referring to EPR recycling money] stays within the industry, it's easy to disburse it, and to getting it going, because once it's gone into the fiscus you're going to struggle to get it out, and it will not be ring-fenced. So, I think it must be run by industry, and industry should pay for the take backs and setting up the logistics, and they can get it in partnerships with municipalities, but obviously then, how can I say, imburse municipalities for setting up that kind of stuff."

P5GA: "...but at this stage, the national department of environmental affairs has taken a decision that these things will be all handled by government, it will go into the fiscus, which is a big problem, because it will not be ring- fenced, it will disappear, and we don't want to have another state capture,..."

P10GA: "No, no, because it's going to end up doing other things, rather than doing recycling. It's going to end up going to the grand, going to wherever, wherever, instead of doing the environmental issues or recycling or e-waste. Government shouldn't be in charge of that money."

P12GA: "Personally I think that a producer responsibility organisation is needed, and they need to manage the funding for the system, because if it goes into SARS, we're never going to see it again, I know that's what government wants to do, national government, but I don't agree with that, I think that the industry should run that and that they should be reporting to government in terms of their recycling rates and targets in terms of that."

P14RDE: "...it all relates to start with the government [Referring to the initiating of a recycling fee], but you also need an electron, you also need an alliance that is sound, that can maintain and be in contact with the suppliers, with the government, with the OEM's, with the manufacturers, with the resellers."

P14RDE: "No. Oh, no. No, not at all. They should initiate it, but I would ... Ja, I wouldn't trust the government to be in charge of a fund like that at all, I would never, ever, ever, ever, no, no. I would rather have a financially strong institution, like your Alexander Forbes, or these kind of guys, Deloitte and Touche, these kind of guys that have the ... or Investec, these guys that have the financial know how, and they are governed, who watches the watchdogs? So who's going to govern the government? Nobody. But at least you've got your financial services Board that can govern these financial institutions."

P17RDE: "SARS should not be solely responsible for the handling of the recycling tax, but Treasury, DTI, and the DEA should be the combined group to ensure that the recycling tax gets ring-fenced and then distributed to the body that will ultimately steer the e-waste process."

P19SCM: "Shifting the responsibility, you know, to industry on the one end, and then potentially, you know, creating an additional tax that could then also assist government in terms of doing many other things, but I think that's the big problem, you know, where we see that EPR is being seen in a very short sighted way,..."

-Producers as EPR-Recycling system funders

P2ES: "So I think, firstly from my standpoint, I subscribed to the International Principle Polluter Pays, and that starts with the manufacturer, importer, OEM distributor, including the internet distributors. So once you start there, then for me it creates closer loops, if you move from the linear economy to the circular economy. So in South Africa, initially right now we're still in the linear side where people buy something, they use it and they throw it away"

P4ES: "...I think the public do need to feel the cost of it somehow, but also the manufacturers, because what you start finding is that the manufacturers are the ones producing sub-car machinery and technology depth of using, you know, poor batteries that only lasts a couple of weeks, you should suffer for the poor quality of the product that you're making. So ja, I definitely think it should predominantly be the manufacturers and the consumer needs to also"

P4ES: "But it becomes difficult, ja, it becomes difficult when it needs the role of government that goes into a PRO, who pays for that, then you'll probably find that it has to be the manufacturers who have to cover those costs, and if the manufacturer makes the product or import fee, that's how the import fees work, but that would have to go to the PRO's. So for instance, I think with Petco, Coca Cola pays them an amount, okay, and then they have to meet certain goals, and if they meet those goals, then they get more money and more money. So the same thing would have to happen where the manufacturers would pay like, let's say there's like a fee for a cell phone is one rand, they would pay that one rand to the PRO, and they would put that one rand, they would recover that one rand cost from the product, and then when you purchase it, it will say one rand on your payslip."

P5GA: "The interesting thing is, this actually exists already, but they're not doing it yet. The WEEE legislation in Europe says in any case, so if Philips and stuff says something like this in South Africa, they're supposed to already be binded by the same provisions that is already on there, and unfortunately they don't do it, and I do believe this is the way of doing it."

P8GA: "Just in terms of that. Just right at the beginning most of our electronic stuff is actually imported. So, I think in terms of importation, the company is responsible for the development or the manufacturing of those things, I think they need to contribute towards a fund, and that fund can also be utilized, you know, the money comes in, it goes into a fund, that fund can be used in terms of setting up dismantling facilities, assist with the transportation as "P5GA" indicated, you know, with the cost, especially in the rural areas or your outline areas, but then it can be done through governance, a mechanism that will distribute that funds."

P8GA: "I think producer probably have the biggest contribution [Referring to funding] to make, and then a decision in terms of how the responsibility then gets assigned to a retailer and a consumer."

P9GA: "EPR, you know, it's the responsibility of the manufacturer, so they drive it, they ensure the funding thereof, and who should run it, so they basically set up the whole thing. I mean, the model said, I know of from other countries, that's how it's done and it's been running successfully for years, and I think we should try and do the same. We should have manufacturers establishing an entity that would ensure the funds are distributed and that it complies with whatever government says it should do."

P9GA: "The money should come from the same people who are producing the products, I mean, we ... the question is that why is this now a problem? Yes, it's convenient for me, but it's a problem, because you manufacture it, and in your manufacturing you should have factored in that at some point I'm going to have to throw it away, or recycle it, or whatever, you know, and you get a phone like this one, and it says don't throw it in the dustbin, where must I take it? What are you providing for me, you know, to ... are you going to come and collect it? Are you going to tell me where I must take it, if you say I must not throw it in the dustbin? If in my country, my village, wherever I come from, that's the only method that I know, you understand, so when I buy it, you must already have a plan on what I must do with it, you must inform me. So the money would definitely have to come from the manufacturers themselves, they must provide the system of collection, including the funding thereof."

P10GA: "You know what, that one also I think it would help, it should happen, because the producer should be responsible for the waste that they generate, but then how they should be managed, I think maybe ... because if we say that Makro should, let's say for example I buy a microwave and take it back to Makro, if we are saying Makro should manage that, I think in a way we are going to have a challenge. Their business is to sell whatever they are selling, their business is not to take back or manage whatever they take back."

P10GA: "No, but in that way I think it's a bit unfair, because I'm paying for something that I didn't manufacture or produce. I think the polluter pays principle must go back, LG must pay a fee, that recycling fee should be paid by LG, not by me as a consumer"

P10GA: "You see. I know I want the machine, I'm going to use it, but for recycling, I'm not going to ... I'm not interested in recycling this machine, why can't LG pay that recycling fee?"

-Collection of EPR-Recycling money

P1ES: "So ITAC is important in terms of creating proper systems that are going to protect the local market, as well as enhance opportunities for local beneficiation."

P3ES: The moment it [referring to EEE] comes over the border, the moment it gets actually imported into South Africa. So it would need to be done in corroboration with SARS and ITAC (International Trader Advisory Commission) as well.

P3ES: [But SARS would not physically collect the money then, or would they?] "No, you see that is obviously not what we want. We don't want SARS, because anything that is collected by SARS never seems to see the light again, but the numbers, we need the numbers, we need to know the numbers of the customer codes, we need the import volumes."

P3ES: "If that's the market, the market share, it's along the market shares, so if Samsung bought a hundred TV's, new, and twenty used or something, there's obviously a different ratio, and then there would be Sony, and there would be some other TV ... and then they would say okay, there is 100, those are nine thousand, those are five hundred thousand, so what makes up a 100%, and that would be for that category of TV's, okay, that would be your obligation that you pay to that respective PRO."

P3ES: [Researcher-...if Samsung imports a hundred TV's, SARS can tell me they've imported a hundred, so we know Samsung must pay a hundred whatever?] "Yes, exactly."

P3ES: "Setup with management of a registry to capture register, again I think that would fall onto the thing of a PricewaterhouseCoopers, because they will get the data from SARS and ITAC on import levels,..."

P5GA: "It [referring to EPR recycling money] stays within the industry, it's easy to disburse it, and to getting it going, because once it's gone into the fiscus you're going to struggle to get it out, and it will not be ring-fenced. So, I think it must be run by industry, and industry should pay for the take backs and setting up the logistics, and they can get it in partnerships with municipalities, but obviously then, how can I say, imburse municipalities for setting up that kind of stuff."

P5GA: "...but at this stage, the national department of environmental affairs has taken a decision that these things will be all handled by government, it will go into the fiscus, which is a big problem, because it will not be ring- fenced, it will disappear, and we don't want to have another state capture,..."

P20SCM: "I'm just highly worried that if I have to charge the client, say R400 or R200 additional, I've got another 100 forms a month to fill in to some Government organisation."

P20SCM: "And as a small business, I'm already overloaded with all the statutory stuff, it just becomes too much."

P20SCM: "So, if they manufacture and they declare to say they have manufactured a thousand fridges last month, it doesn't matter if it's not sold yet or whatever, it's almost like declaring at manufacturing point we have manufactured so much that there's a possible levy to be paid"

-Visibility of recycling fee

P1ES: "I think it should be a built-in. I think as soon as they see it, if you had a R2.30 per kilogram tax that was put into it, it needs to be built-in, otherwise it becomes a problem. The issue is in terms of effective implementation of the system because they're going to need to show the consumer, because they will question it. We need to show the consumer that there are systems being put in place to manage that product, otherwise you're going to end up with another producer debacle where the guys absconded two billion rand and only got to 17% recycling."

P4ES: "I think this does lead on to your ... the next section, but essentially it has to be an EPR system, and I think the public do need to feel the cost of it somehow, but also the manufacturers, because what you start finding is that the manufacturers are the ones producing sub-car machinery and technology depth of using, you know, poor batteries that only lasts a couple of weeks, you should suffer for the poor quality of the product that you're making. So ja, I definitely think it should predominantly be the manufacturers and the consumer needs to also ... the consumer does need to feel the cost of it, but I don't know how they would, I don't know how you could tell the consumer to pay, unless it comes in the product, ja"

P4ES: "I definitely think we should. I think it's because people can understand that they're part of a system and that things are actually happening and that there's actually like a sort of qualitative, quantitative numbers that are going towards something. If you're just giving someone a product and they don't know ... well, all the costs associated with it, they don't really know why they're paying so much for it." [On the researcher Question: "Do you think the consumer should see a recycling fee?"]

P4ES: "But if they can actually see where it's going, then ja, I definitely think it makes it easier to swallow it, if that makes it all easier to swallow. For me personally, I don't ... if I saw that on my slip I'd be very, very happy, I won't be too upset."

P4ES: "I think it should be separate. It would make everything so much easier and understandable for people if they understood that there was a VAT and that there was a recycling fee, and then there was the actual value of the product."

P4ES: "Because what you start seeing ... and the thing is, if people educate it, and if people are aware of why they're doing this and they see that their product is like five rand, then they will say but if it's five rand, that means that it must take a lot of money to recycle this product, or to do something with this, maybe I should not just think about throwing it away, or something like that, it creates a consciousness, it's sort of like a ... where everyone's like okay, maybe we should all be recycling now because it has value."

P16RDE: "As a consumer, you don't want to see it, but as a realist you should be seeing it, because it's showing you that there's something negative in this item, why you have to make sure it's been recycled, so I think for awareness ja, it's great for them to see, but for a convenience to print a line out on a slip to show that you paid recycling for that. Ja, I think that's semantics."

P19SCM: "Once again, it's really stepping back and looking at extender producer responsibility as the bigger picture, in terms of enabling empowering the end user, the consumer, to as a first step, to buy the correct product in terms of sustainability, in terms of environmental impact, and then once again, we take that decision into account, and ultimately in five, or ten, or fifteen, or twenty years' time we then put a visible fee again, we lose that incentivisation, we lose that creativity where people need to be informed, from starting to use the product, and not just focusing at the end, well, now, if it's treatment time, I need to pay."

P19SCM: "Ja, we also do not believe that a visible fee is definitely the right way to go. At that point in time we believe the industry should be closer, you know, it should be a build in cost....Once again, it's really stepping back and looking at extender producer responsibility as the bigger picture, in terms of enabling empowering the end user, the consumer, to as a first step, to buy the correct product in terms of sustainability, in terms of environmental impact, and then once again, we take that decision into account, and ultimately in five, or ten, or fifteen, or twenty years' time we then put a visible fee again, we lose that incentivisation, we lose that creativity where people need to be informed, from starting to use the product, and not just focusing at the end, well, now, if it's treatment time, I need to pay."

P19SCM: "So the recycling fee should be built into the price of the product...to enable you to make an informed decision. If that product is very low quality in terms of recyclability, you should naturally, theoretically, you should be paying a little bit more for that product."

P20SCM: "I wouldn't be too much worried to state the amount. I think we should rather have to say okay, this product is manufactured to be recycled at, let's say 50% or 70% is recyclable."

P20SCM: "...but you can rather have other factors, you might have energy regulations, you know, where the A triple plus uses 80% less power than the other one. That is becoming slowly also something that people look at, the power consumption. Again, we've got our laws that, I think you cannot sell anything below A+, but the public themselves are not really always aware of that, or water consumption on the washing machine, or on the dishwasher."

6.10.4-Management of EPR

-Producer Responsibility Organisation (PRO) should manage all EPR functions

P1ES: "In an ideal world I would prefer a PRO to be self-standing, without government involved. The problem with that becomes the same issue as you now face with current PRO's, like POLYCO and PETCO where only certain people are paying money into that, and that just leaves a whole bunch of guys out there who now have a market advantage, because they're not paying that EPR [Meaning recycling fund], and so there's positive components to both sides at this story. I mean, the concern is literally just the non-ring fencing of those funds, but the systems and structures I think, right through an industry related PRO, or through a waste bureau linked PRO is the right way to go."

P1ES: "It has to be the PRO. The PRO has to be the visible component of the system. The PRO needs to take the ultimate responsibility for it, but the PRO also needs to be able to have a handle on accountability and responsibility back to the waste bureau. They're not getting the funding, they need to make projects happen, they need to apportion blame, they can't be the blame and you know, that said, we're not putting in the right structures and facilities and everything else. They're not getting any money from government. So that level of accountability has got to come back, but the public face of it has got to be the PRO."

P3ES: "It should be people that are appointed as competent people through EPR money, so ultimately it should be the producer's right, since the producer is paying for this, to actually ring-fence that money, which I'm very much thinking that is at the key of this whole EPR as working, so EPR sounds great, but I think our government has greatly busted the idea of what an EPR could look like, the whole idea that, you know, you call it a levy, it's supposed to go to treasury, for me it is a systemically veiled attempt to just obtain money, ill gotten money without transparent feedback and, you know, if the industry is lucky, they can get a small percentage, but that is just another way to raise taxes, and if it's like this, I'm digging in my heels right here and right there"

P4ES: "But ja, they would have to control the funds, but at the same time it should be completely transparent. So again, if you look at REDISA, one of the reasons why it failed is because no one was actually able to ... well, one reason why it failed and got so far, was because no one was able to actually see what was going on. So if the public were able to see what was going on, or at least industry are able to see what's going on and to monitor, then it will a) reduce the amount of corruption, and b) everyone will actually understand how everything's working, and as soon as people understand how things work, they won't second guess it."

P5GA: "...I believe that it [Referring to recycling funds] should be run by industry, and that government should play the compliance marketing role. If it's done by industry it's much easier to get it out, and with the Redisa example, they say this is why it shouldn't be handled by industry, but on the other hand, plastic bag levy, why did government do that? They fumbled totally. So, then it shows that they should also not handle it. So, I think in both examples, it would be a bit of a problematic, because it's the first time that it's implemented in South Africa, we must learn from that, and we must write very strong, or put in very sort of checks and balances to make sure that it's happened. It stays within the industry, it's easy to disburse it, and to getting it going, because once it's gone into the viscous you're going to struggle to get it out, and it will not be ring-fenced. So, I think it must be run by industry, and industry should pay for the take backs and setting up the logistics, and they can get it in partnerships with municipalities, but obviously then, how can I say, re-imburse municipalities for setting up that kind of stuff."

P5GA: "So, the setting of the prices is very important, but I definitely think it should be done by industry, and through the industry waste management plan, and they should handle the disbursements to the different PRO's that they can fund the systems."

P9GA: “EPR, you know, it’s the responsibility of the manufacturer, so they drive it, they ensure the funding thereof, and who should run it, so they basically set up the whole thing. I mean, the model said, I know of from other countries, that’s how it’s done and it’s been running successfully for years, and I think we should try and do the same. We should have manufacturers establishing an entity that would ensure the funds are distributed and that it complies with whatever government says it should do.”

P12GA: “Ja, the way I see it is that ... I’m not an expert on EPR systems, so I can’t prescribe how this thing would look, but I know that there had been e-waste take back programs in multiple countries in the world, and I think that there can be some lessons learned in South Africa, from those other systems, to say okay, we need a low tech system which is not going to be fraud with administrative hassles and that type of thing, and I mean, there must be lessons learned from other research that’s been done in other countries on take back systems. Personally I think that a producer responsibility organisation is needed, and they need to manage the funding for the system, because if it goes into SARS, we’re never going to see it again, I know that’s what government wants to do, national government, but I don’t agree with that, I think that the industry should run that and that they should be reporting to government in terms of their recycling rates and targets in terms of that.”

P18RDE: “Look, at the end, like we said, the suppliers would be the responsible, so that’s part of his moneys already. I think that they should be responsible for that money, and whatever comes back, should be ... you know, it should go back to them, because it’s not free for them to get rid of whatever is coming back, you know, you need to dispose of, or get rid of it, and I think there’s definitely going to be some fees involved, if it’s for instance, especially fridges and freezers, you know, if it’s something you can’t get money back for, like we get for the rest of the e-waste, you know, it’s something else. I don’t know what they will do in that case. Yes, the supplier.”

P19SCM: “A PRO need to support and look after the industry. Once again, it needs to be an autonomous, not for profit body. It needs to assist government, all of the government needs assistance in terms of enforcement, or specific industry, or it needs to have oversight, and the core function of a PRO is in terms of the financial mechanism, which is core, the extender producer responsibility financial mechanism for end of life, is to perform the collection, obligated collection, fair collection from the producer principle and to do disbursement in the correct way”

P19SCM: “So we believe that PRO is just a ... it should be an enabling, an independent enabling function, and whether there’s an HP today, or an Apple tomorrow, that autonomous body need to serve the need, the obligation in terms of extender producer responsibility for the industry indefinitely.”

P19SCM: “So my first, I think, industry, and I speak on behalf of industry as it should not be in the form of a tax. It should be managed. It should be driven by industry that has the responsibility, that has the producer responsibility....in terms of the product that becomes a waste. So very, very important, number one, not a tax. Number two, it needs to be driven by industry. Number three, it needs to be done in a fair and level playing field, as to, once again, maximise the value for an economy, for a country.”

-The need for transparency

P1ES: "The issue is in terms of effective implementation of the system because they're going to need to show the consumer, because they will question it. We need to show the consumer that there are systems being put in place to manage that product, otherwise you're going to end up with another producer debacle where the guys absconded two billion rand and only got to 17% recycling."

P1ES: "Essential to the outlook of this entire thing for the industry, is that that PRO needs to be the responsible organisation that is educating the public and the payer and everybody as to what is happening, so that people can see the real stuff happening on the ground. We need to be able to quantify the waste streams, we need to be able to benchmark that on a yearly basis, showing how we're increasing, show what's happening, how many jobs are created, how much value had been put back into the country, and that information needs to be accessible to anybody who demands it. It's got to be publicly available information."

P1ES: "You want full accountability and responsibility, you want transparency..."

P1ES: "If we don't do it with a level of transparency and accountability, we're selling ourselves up for hiding, and we need those people without invested interests, so someone like an OUTA or a Safe South Africa would be an ideal component having it, because they're looking after the best interests of the community, they have not vested interests."

P2ES: "...every two years or every three years you have a balancing thing where you balance those numbers. That way you know what the money is that's been collected by government in total, actually, because you've got it directly from the OEM's, you know what you ask to get to recover, so at any stage you can say to government, based on this from the last year, or from the last two years or at any point in time, you still have x amount of money in the kitty, so to speak, and that's a hundred percent transparent. They can't say no, they haven't got it, because we've got the actual figures of what that money is, and that should be used as a reserve, because if you go and speak to the guys in the WEEE forum, that's why some of the PRO's have gone out of business there, because all of a sudden there's an oversupply of copper, which they all refuse to buy, copper fractions, because the price had just gone far too low. So that's what you use to make the things stable."

P2ES: "...we're busy developing software that will be a further check and balance. Every bit of waste that comes into the system, because everybody has to be registered, whether you're a collector, one man waste picker, to a hundred billion recycler, you have to register on the system, and any money that gets paid from the fund, is tracked and traced, and is audited by independent auditors. In addition to that, we are training and developing auditors to go out on a regular basis to audit facilities without notice. So from auditing your recycling point to auditing your collection point, once again, just to make sure that things are transparent."

P3ES: “I mean, it’s not that we don’t have any recycling systems in place, you know, and if the government now tries to replace them, and shut those down in lieu of non-transparent unaccountable systems, I would walk away as a producer, and from the discussions that I had with our manufacturers, they have been very patient, and the thing that nothing happens in South Africa, I put the blame firmly on the government and not on the obligated parties.”

P3ES: “I think yes, absolutely so. Perhaps again we need to look at, not just like a rahrahhah non-profit organisation, but someone like ... or for example voluntarily industrial organisations, I would like as a “member of XYZ group” [position mentioned but removed for anonymity] perhaps not be part of the PRO, most certainly don’t want to be paid as a member of the PRO, but I would like to be able to be invited, or to give input, or to be a kind of a watchdog of the PRO. So perhaps they are not part of the PRO as such, but they would be afforded transparent insight in the activities. I would very much like to see that. I would like to know that OUTA can anytime have insight into the books of the PRO, that Groundwork South Africa or you know, any of those grassroots organisations could actually ask what are you doing with the money? Okay, or if there’s any scandal evolving of people getting poisoned because of mismanagement of electronics, that they could hold that PRO to a certain degree accountable, ja absolutely.”

P4ES: “But ja, they would have to control the funds, but at the same time it should be completely transparent. So again, if you look at REDISA, one of the reasons why it failed is because no one was actually able to ... well, one reason why it failed and got so far, was because no one was able to actually see what was going on. So if the public were able to see what was going on, or at least industry are able to see what’s going on and to monitor, then it will a) reduce the amount of corruption, and b) everyone will actually understand how everything’s working, and as soon as people understand how things work, they won’t second guess it.”

P4ES: “It’s a very decentralised way and it cuts out all of the auditors and the middlemen, so it reduces the costs. So ja, you can use Block Chain as a way of ensuring that everything is transparent, so as soon as a sale has been made, or as soon as someone has, you know, dropped off some e-waste, that little transaction has been logged and it’s disseminated into the world. The world doesn’t necessarily know what that information is, but they understand that there is information that can’t be edited.”

P5GA: “...and that will then go in setting up the different waste facilities, but at least you as the person paying for it, will get a direct benefit that you can see, otherwise you’ll see a lot of resistance, people against that, if you don’t do it like that.”

P12GA: “Ja, the way I see it is that ... I’m not an expert on EPR systems, so I can’t prescribe how this thing would look, but I know that there had been e-waste take back programs in multiple countries in the world, and I think that there can be some lessons learned in South Africa, from those other systems, to say okay, we need a low tech system which is not going to be fraud with administrative hassles and that type of thing, and I mean, there must be lessons learned from other research that’s been done in other countries on take back systems. Personally I think that a producer responsibility organisation is needed, and they need to manage the funding for the system, because if it goes into SARS, we’re never going to see it again, I know that’s what government wants to do, national government, but I don’t agree with that, I think that the industry should run that and that they should be reporting to government in terms of their recycling rates and targets in terms of that.”

P19SCM: “So my first, I think, industry, and I speak on behalf of industry as it should not be in the form of a tax. It should be managed. It should be driven by industry that has the responsibility, that has the producer responsibility....in terms of the product that becomes a waste. So very, very important, number one, not a tax. Number two, it needs to be driven by industry. Number three, it needs to be done in a fair and level playing field, as to, once again, maximise the value for an economy, for a country.”

P20SCM: “Maybe it’s another organisation that has got a couple of directors and CEO’s and ... people on the road, that’s going to cost the receiver money to keep that going.”

6.11-Theme 4-Problem areas regarding recycling infrastructure in South Africa and the role of government to address the recycling needs

6.11.1-Recycling Shortcomings and needs

-Lack of recycling facilities in areas and on specific e-waste types in South Africa

P1ES: “The issue around the CRT’s is largely problematic, because one knows and understands the issue around CRT’s is that they had gone out of production, which means that there’s no market for CRT glass anymore, and without an extended producer responsibility profile to handle the CRT’s, there’s always going to be a problem, because a CRT needs to be collected. What you don’t want is your individual refurbishes to be smashing any glass. You want whole monitors that then goes to a dedicated facility that has a cutting facility that’s able to separate out your panel glass from your fit and your funnel glass. Then we have glass crushing operations where we can add value to the non-lead glass, and that can go into the thirty odd applications we found like crush glass market.”

P1ES: “So from that perspective there almost needs to be a government intervention in terms of making sure that hazardous material is not getting in to landfill. At the moment, most your CRT’s are ending up in your hazardous landfill sites, which costs a fortune, which is why there’s so much illegal dumping of CRT’s.”

P1ES: "Nobody wants to pay R1800 a ton to dump CRT's. So these things are getting dumped surreptitiously into our landfills all over the place, which again is causing problems where you're now getting some lead leaching out of the systems. Again, it comes down to a classification process where we need to deep classify the fact that a leaded CRT is not a hazardous material. If that leaded CRT was stuck in a landfill where it's been leached out and your PH is down to 1 or 2 and your temperatures are increasing to 60 degrees, there may be some of the minor lead leaching coming out, but under normal conditions that is lead is oxide that's trapped into that glass, it's not going to come out. So we need a de-classification in order to avoid the stuff going into hazardous landfill in the first place, so that we can actually deal with it in the proper system, and that's going to require quite a big investment"

P1ES: "So the glass cutting machines are expensive, your CRT cutting machines are expensive, your transport logistics are going to be expensive, and the centralised processing facility that separates out the lead from the silica is also an expensive process. That in itself can be economically sustainable, but not if they're going to pay for all our downstream charges in terms of getting that part too. So from that perspective we can look at that, there are technologies like new life glass in Manchester, who very successfully have used CRT glass, separate out the lead and everything else, but then again, they've had a lot of support, because if you look at the hazardous costs in England versus what we're paying, I mean, for them it makes sense because they're actually paying a gate fee to get the stuff processed, which is where the business model works for that overseas. When you look at the circuit boards, the issue around the circuit boards is largely problematic because there's no control from ITAC in terms of the movement of that product. If we looked at some level of limitation from ITAC, that there would be a tax on exporting that product, it would help to look at the financial viability of a local processing centre. In order for this thing to make money it's got to be done at scale, Mintec is busy looking at mobile systems and all the rest of it, and by the time they look at the logistics and everything else, they're never going to make money on this thing."

P1ES: "The problem comes down to volumes, so the issue we're seeing at the moment is that a lot of the recyclers are packaging the stuff up and shipping it off to either Canada or China. What we need to do is, we need to look at local beneficiation, and local beneficiation means that we can't have each of the large collectors trying to develop their own processing capability, because there's just not enough volumes to justify the capital expenditure, which means that you need a centralized facility that might not be owned by the individual collectors, but that provides a service to the industry, and that works on both the printed circuit side of things and with monitors."

P1ES: "Government also needs to play a role in terms of green procurement. So if we start looking at OEM's, who are now driven, like "IT Producer X" are doing now, and I think "IT Producer Y" is also doing, in incorporating a certain level of recyclable components back into their systems, that your policy now is going to drive that, so you create the local markets for your OEM's to use recycled materials locally, you put it into the systems, otherwise nobody is going to buy it."

P2ES: "Because we want to get into beneficiation, because we lose too much money in economics, by exporting all the value, and then you port it back into the country as a finished product, or whatever the case may be. So if we have a system, once again, that is a democratic system and it's a free market based system, then it's fine. Auction is not a bad thing, provided that it's not dominant"

P3ES: "Well, we don't really have a solution, which is problematic. We don't have degassing facilities in South Africa from what I know"

P3ES: "So the question was also raised with a scrap metal dealer, that because we look at funds from Switzerland, you know, to improve working practices, and there was something on the card about supporting South Africa to perhaps develop a degassing facility, if that would be in the interest of that particular large scale scrap metal dealer, and the answer was no, actually not, because they know that this get somewhere released in the veld, but it's not part of their business model, it's not part of their problem, because when the stuff arrives, the transformer oils are removed, when the stuff arrives the gasses are removed, so it's the small guys that do that, and they do it illegally behind walls, and I'm not sure how we could actually stop that."

P4ES: "Do you think that it will be open to exporting as well? Because I think what South Africa should try to focus on is to try and keep resources in the country."

P4ES: "Whereas what a lot of guys do is, they will just take and collect a whole bunch of electronic waste, put it into a container and then either ship it to China or Germany, or what not. And so, that's just easier to do that, they'll be out of a lot of money, but it doesn't matter, because it was a lot easier. So ja, maybe doing it this way is also a great opportunity"

P4ES: "what happens to lithium-ion batteries. If all your cars in South Africa have a demand of batteries, what's going to happen to them? Are they going to be recycled? Is there going to be an EPR system for those, we don't know"

P4ES: "I'm glad you did bring that up, because often what happens is, it's quite a ... in South Africa we often always forget about the rural environment, of the natural environment that is most open to contamination or neglect. It's quite hard, because if you look at it from ... if there were no subsidies, or no sort of assistance, it becomes hard, because the economies of scale aren't in the favour of the rural environment, but as soon as you start having this situation where you when you can't start subsidising, putting in places, situations, then it does become more attractive."

P4ES: "But also, particularly in the Western Cape we've only got one hazardous landfill site that's actually really equipped to take that such hectic...materials, and so all the other smaller local municipalities don't really have ... The city of 'City A' does, and maybe Stellenbosch to some point, but a lot of the other local municipalities don't, and looking at it from a South African perspective, I can't remember offhand what it is, but a large majority of landfills aren't actually ... don't meet the requirements for disposal of e-waste. So the only real one that we have is "Landfill A", which is a 'City A' landfill, and then the private landfill "Landfill A", so there's two "Landfill A's" in 'City A', one is public, one is private. So from a landfill perspective we only have the one, so if any other e-waste is going to any other landfill, it's definitely not equipped."

P4ES: "Okay, cool, ja, so in South Africa, in the Western Cape we actually don't have any [Referring to recyclers], it all goes up to Johannesburg. We have some sort of pre-processing that happens here, so with the fluorescent tubes there is a depot in 'City A', that's 'Industrial Area A', it's Reclite, they have a facility in Johannesburg, but what they do is down here is that they just essentially collect, and if there's any crushed that it's in drums and they transport it up to Johannesburg where they process it, and I'm pretty sure that they will be investigating setting up town here, because of the balance of fluorescent tubes, but in terms of actual recycling, there isn't anything here"

P9GA: "Oh ja, there's no money there. Actually you pay, if you want the recycler to come. All they can take from you is the metal, usually, and maybe other things, but they don't make much money out of the white goods."

P9GA: "CRT's, there's no potential for it, as far as I know, they are being disposed at a landfill site."

P9GA: "There are many areas. I mean, with any other recycling facility, most of them are located in Gauteng province, and within Gauteng province there are some areas that do not have, but at least, you know, access is not that difficult, and if you go to North West, or Northern Cape, or Free State, most of their wastes come here in Gauteng anyway"

P12GA: "I will say low incoming areas. You know you can underestimate all those people, but when you look at the amount of TV's that they have, laptops, and all that, what is their life span, what do they do with those things once they are finished?"

P12GA: "Ja, I've just seen that working in the packaging industry where the ... because the product responsibility organisation is getting levies, and part of their mandate for that money is to invest in markets, and invest in recycling facilities, to provide a demand for that material, and then that material becomes recycled a lot more, because there's a market for it within the country." [On Researcher Question: "So if there's still a lack, let's say for small batteries and maybe for fridges, freezers, the producers must basically enable or see to it that recycling facilities get erected and ..."]

P12GA: "In other cases I think additional responsibility by the product manufacturers is needed, because that kind of recycling technologies should start being invested in in this country, we shouldn't be selling our circuit boards to China for recycling. I believe that is the responsibility of the manufacturers and the producers to be investing in that"

P14RDE: "But the main focus should be on the electronic waste, onto getting the electronic waste to the correct people, but once again, the body that you have, should know that the people they are dealing with are credited recyclers, their electronic waste is not going to go overseas to places like China or end up in a place like the DRC, and all these places they've got the massive landfills where things are just being burnt to get the copper, in India or in China."

P14RDE: "CRT monitors cap, your fluorescent tubes, toners, your laser drum toners, lithium-ion batteries, a very, very big problem for us, it's such a big problem for us... because there is no safe recycling solution in South Africa at the moment for them. So lithium, ion, nickel hydrate, CRT monitors as well as your toners, like for your HP printers and things like that, your toners is made from a very, very hard plastic, that is not easily malleable or easily re-melted and reused again, so that is a big problem for us as well."

P14RDE: "At the moment there is nobody that's doing that, the reason being is that the fridges and things are too big, but also, you get your informal, if you want to put it this way, informal recyclers that go and they cherry pick and they take out the copper and the nice things, everything else just get dumped in the land fill, or it just gets disposed of in a non-environmental friendly manner."

P14RDE: "Okay, your large fridges and freezers, at the moment there is no hundred percent secure way to safely dispose them in the environment, due to the gasses that are embedded into them, into the doors, into the frames, as well as your gasses inside your compressors of the machines. So the only, very, very safe way to do that, is to contact a responsible recycler that can issue a certificate to say your gasses in the compressors have been extracted, this is what happened to the gas, here's a certificate for it, this is what happened with the rest of the electronic waste, this a certificate for it. So once again the onus and the responsibility should land on the supplier, or the re-seller, or the OEM and the manufacturer, to make from manufacturer, to re-seller, from re-seller to client end user, to make them aware of this is what you have, this is the manner it should be disposed of."

P14RDE: "Once again, education, but your rural areas and your informal settlements and your very low income areas, very, very, very, very ... is found wanting, and it's, you know, if you drive through these places, you'll see things just lying all over the side of the road."

P16RDE: "Ja, there's definitely a lack of facility, because just find me a factor, it's still going to land dumps so it means there's a lack of facilities."

P19SCM: "No, nothing. So South Africa hasn't got any capabilities, not in terms of batteries, there's no battery processing, no CFC, no extraction on, you know, from the oil side of it, from the foam side of it, you know, that's where most of the CFC's end up in."

P19SCM: "...and I think all of your lower income areas are lacking that infrastructure, and obviously your rural areas, they've got nothing"

P20SCM: "Well, we've been in the appliance trade for many years, and I've never really been approached by anybody who says can I formally buy stuff, or can we formally just pick up the stuff for free? It's always been unemployed person which says, you know, I've got the motor has got some copper in there, I'll take the whole sheet, don't worry about it, we don't know what happens with that next, but I'm not aware that there are places."

P20SCM: "Ja, ja. We must remember that, I think the one product that is most difficult to recycle, must be typically, refrigeration, because you've got foamed in liners, very hard to separate ..."

-Lack of electrical equipment refurbishing centres

P1ES: "According to me it should be collected by authorised responsible collectors who are going to take it to centres where it will be properly dismantled and/or refurbished."

P1ES: "So the idea is to rather create multiple applications for developing small scale certified and trained dismantling refurbishment centres, where it goes to the right place, it's stored correctly, it is separated correctly, they're trained which components can be separated, and thereafter it then separates out the issues of the hazardous versus the non-hazardous"

P4ES: "The other one I was talking in terms of the rural area I was talking about social refurbish points"

P4ES: "So to separate them into categories, and I think definitely in terms of refurbishment, refurbishment, if you speak to a lot of the small guys, they say that refurbishment is their number one income generator, recycling as a secondary income. So refurbishment must always be on ... as a primary focus"

P5GA: ": I've seen in Germany, we've got regular contact with Germany, in the state of Bavaria, and how they do it there, not necessarily the PC's, but the other, the white goods, it would go to the, say drop off, the material recovery facility and stuff like that, and they would have a little shop where they sell it, and they have it there, and you can go and buy it, because you're trying to encourage the re-use as much as possible, then you would purchase it there, and the stuff that cannot be purchased, it will then go into the stream for recycling.

P5GA: "So, if you're going to throw out a PC at this stage, and this thing is three years old, and it's got a lot of value for a lot of people here, then there is maybe that can be re-sold and stuff like that"

P7GA: "I've seen a few in the city of 'City A', I know the one in "neighbourhood A" as well, not an auction house as such, but it's an open shop. It's an open shop where they get values, and I think it's a very ... I can't say that it's throughout their material recovery facilities or disposal sites, but that specific one in "neighbourhood A", they've got, I think it's just the workers that are there, they've formed their own little shop, and people that come and do recover and pay for materials that are there that they can use, it's just a little kitty that they spread amongst themselves. So, it's their own localized solution towards, not a formal auction house as such, but they've been quite successful, because I've had a discussion with them on it, and they said that it's just an initiative that they got permission for, and they took up on their own, and a lot of people had been there to buy. I mean, a lot of guys buy it from there, and as an example, they re-sell it at the flea markets. So, they collect a lot of their goods there and at the flea markets, all very informal, but it's keeping their volumes down there."

P15RDE: "You can do that, but when you collect this kind of scrap, some of it will still be functioning, it might be technically dated, but it will be functional, and there's somebody who could use it, a school kid or something somewhere. So your first separation must be this is now stuff that can be repaired and it will become useful, that's your first."

P19SCM: "I do not believe the end user, or the household, is in a position to accurately determine whether this article should be discarded or disposed of, or could potentially be refurbished, or potential parts of it could be reused"

P19SCM: "Get people to understand in terms of electrical and electronic equipment, that there could be value, even if it's not working, very important, so that we can make an informed decision"

P19SCM: "And that brings it back to incentive and I believe that we can focus on that intermediary step and assist the consumer, to first make an informed decision to see if there's still potential for refurbishment, or reuse value, I think that will be a very good solution, and if you look at your second hand triple EEE, your second hand electrical electronic equipment dealers, we have a national footprint. Maybe not that close to the rural areas, but much closer to where a recycler would be today."

P20SCM: "So, there is a way of actually selling the equipment that's not being used, which is still functional."

6.11.2-Government's involvement in addressing e-waste recycling needs

-Government should facilitate recycling e-waste

P1ES: "There's a lot of very, very important roles that government can play, and I think a lot of people are saying to tell government to stay the hell away, but I think government needs to accept its responsibility in terms of creating an enabling environment, which is what government should be doing"

P1ES: "The other issue in terms of understanding the backup and support from government is to look at all the issues around the transport of hazardous waste, around looking at the storage issues, looking at the development of norms and standards, looking at the provision and creating an enabling environment by providing facilities for groupings within an urban and Peri-urban environment, where government has land and facilities that a small scale group can't go and rent a mini factory, they can't afford it, but government can create an enabling environment by providing the space to do so. So there are so many ways that government can and should be getting involved."

P2ES: "Well, I think government is the enabler, you know, so we think we've got a plan as other sectors will submit industry waste management plans, but if government doesn't enable it by a section 28 notice, or section 18 notice, it's never going to happen. So that's government's role, and then government has a further oversight role to play to ensure that the PRO's are doing exactly what they said, not the fiasco that they had with REDISA."

P3ES: "Government needs to be the enabler for people to do the work that they are set out to do and they are supposed to do. An enabler can definitely help with public education, that's part of the role of government as well, and enforcer."

P4ES: "So essentially National government's role is to sort of facilitate, to promote something. So in this case their role is to promote the extraction or the separation of the electronic waste, gaining value from it. So their role would purely be to put in the right legislation, to allow the private sector to do it the private sector is always build on efficiencies, so they would try and push to get as much value out of it as possible. So for me it should purely be for the facilitation and promulgation or legislation that enforces ... because they would also have to enforce every stakeholder register with a ... so every e-waste or electronics stakeholder register with PRO, and then also obviously have your punitive mechanism."

P4ES: "But they should not be in charge of operations of the PRO at all, other than maybe Steering Committee stuff, but ja, I don't think, particularly with what's the view that business has at the private of government at the moment, it shouldn't be that, because then you start losing support."

P5GA: "The only reason why the REDiSA plan was a shamble, is it was our first plan, and they allowed REDISA to dictate the terms. That general requirements and the waste act, and then basically REDISA didn't meet the requirements, but REDISA did go and tell the minister, this is how we will do it, it should have been the reversed, the minister should have told REDISA this is how I want you to do it, these are the following things that you have to build in, and they relied totally on industry."

P10GA: "Government should be involved, the issue of environment is no-no, the issue of the landfill site is no-no, one way or the other the government must come up with something to assist, not only e-waste, with all the recycling or with all the environmental issues, or all the work, but the challenge that we are having, our government is not hands-on on the issues of the environment"

P10GA: "...they should get committed, they should make sure implementation is done, monitoring is done. You know, I don't know how to put it, but I just feel that our government is not doing enough. I mean, if you go to overseas, overseas you don't have a lot of street sweepers, you know, to them waste on the street is no-no, you have to recycle, whether you like it or not."

P12GA: "I think ja, I think I see government as a regulator, and an enabler in this environment, and I think there is room for improvement at the moment, I mean I can see that we regulate, but we could probably do more. I mean, I think that is the role that government should be having here, to make sure that these little waste collection guys are not dumping their e-waste and all the CRT screens in the river, you know."

P12GA: "I think that government, one of the important roles could be to create an enabling, not restrictive legislative environment, and something I heard this morning when we got feedback from that PAKISA was something along the lines of requiring industry to create norms and standards, but allowing them to come up with the norms and standards, because there's nothing worse than government sitting in their ivory towers and writing norms and standards for e-waste recyclers, which are completely unrealistic, which is something that's been done, quite a lot recently with different waste streams."

P12GA: "And I think that's a really good thing where the government allows industry to write their own norms and standards, and government should not overregulate in terms of licenses. Obviously there are some facilities that need a license, but if possible, norms and standards which the industry creates, and government checks, is much better than having to have air equality license and this license and the other license..."

P19SCM: "But it's a focus, a very specialised referee function in a specific industry sector, or vertical, but without government, you know, government needs to be the glue, but they need assistance...they need assistance basically to put everything together. So without the regulation, without that legislative framework you will not be able to put that fair level playing field."

-Government should set up legislation

P1ES: "...but in terms of legislation, it's very important, with regard to setting procedure and protocol, I believe that we need to have legislation that is going to inform at national, provincial, district, local level. How asset management facilities are going to work with regard to e-waste and ICT waste and white waste. There has to be a very clear mandate that is overruling all of the inadequacies and intricacies of all these different systems to have one unit that everybody deals with. It is your responsibility as a corporate or as an organisation, that if you have written off an e-waste asset, it now needs to be provided to a suitable, local contractor who is certified and compliant to manage that waste stream, so that you take all the shit out of the system, otherwise it becomes a problem"

P3ES: "Of course legislator, and not just making legislations that never get enforced, or making legislations that no one can adhere to, but actually consulting with the stakeholders that will be affected and not from a top to bottom approach, but to really sit down with those people and learn the realities of what it would mean to have this by-law in place ja."

P4ES: "So essentially National government's role is to sort of facilitate, to promote something. So in this case their role is to promote the extraction or the separation of the electronic waste, gaining value from it. So their role would purely be to put in the right legislation, to allow the private sector to do it the private sector is always build on efficiencies, so they would try and push to get as much value out of it as possible. So for me it should purely be for the facilitation and promulgation or legislation that enforces ... because they would also have to enforce every stakeholder register with a ... so every e-waste or electronics stakeholder register with PRO, and then also obviously have your punitive mechanism."

P5GA: "I think they should put the legislation in place that will turn the checks and balances that has to be done, what's the internal and the external controls that should be done. If I compare something, okay as soon as you compare apples against apples, but we've got one of the best banking sectors in the world, and it's been administrative on a very strict bank act, and it's not like government is interfering directly, but because the checks and balances are built into that piece of legislation..."

P5GA: "...at this stage the waste bureau has retained a lot of functions and responsibilities for them, in some instances they would say that they will write some of the waste industry management plans, but they are not specialized enough. Who knows best? Industry knows best, so government should just have a role of playing, to say that this is the systems, how we're going to monitor it, and to make sure that there's both internal and external mechanisms, they're doing like internal and external audits, that's doing that. Then it's easy."

P15RDE: "Yes, you could, but they get involved in things which they shouldn't be [Referring to Government]. I think the government should say that every house that's built must have a hot water system, solar system hot water, because that saves energy."

P16RDE: "As far as the starting point was ban dumping of e-waste, because that's not going to help anyone."

P18RDE: "Ja, it's not happening. So definitely from the government's side, you know, legislation, it needs to be part of the laws, and there should be audits and that type of thing that there can be an audit trail of how it should be done as well, that you can track it and see what's happened to it. I mean, if you take something back you need to sign in a register that you've returned whatever, and that's the first step where you will check what had come in and then where did it go. You have to have proof of those things, that's the only way."

P19SCM: "But it's a focus, a very specialised referee function in a specific industry sector, or vertical, but without government, you know, government needs to be the glue, but they need assistance...they need assistance basically to put everything together. So without the regulation, without that legislative framework you will not be able to put that fair level playing field."

P20SCM: "Government would put the law into place, to say right, this is how it has to work, and then hope actually that the public adheres to that. How are you going to control it? If somebody pitches up with a fridge at a landsite, to say well, you cannot dump it here, take it away, there's the following five points where you can drop it."

-Government corruption

P1ES: "The waste bureau would then have its own internal costs as well, and of course that being a government thing, you're probably going to have a whole bunch of people doing nothing with fat salaries, they would then determine how much of that now goes to each of the PRO's, and the PRO's would represent each of your industry associations with regard to the different waste streams. By the time it trickles down there it's been diluted to the end degree"

P1ES "The corruption and fraud and mismanagement and everything else in government, no."

P3ES: "...because my personal experience shows me that government can be the biggest culprit, first of all, trying to source service providers where they can actually make a buck out of e-waste. They actually have been shopping around. I have been even phoned ...(section removed to ensure anonymity) by the Department of XYZ, trying to find out if I can recommend who would pay them the best buck for e-waste, and it's clearly not what we want to see."

P3ES: "You know, so government can be the biggest culprit, because they're trying now to push credible recyclers into the corner and say, but you're not giving me anything, you just collect from me, but that guy down the road he's actually paying me, and why can the guy down the road pay me? They don't think along those lines, because he's cutting every corner in terms of health and safety regulations, that is why he can offer a price where the likes of "Recycler A", you know, which has the whole health and safety requirements, is not as competitive as that guy that actually deliberately runs under the radar, and is legally not compliant."

P3ES: "...the way it works with government, is their equipment gets devaluated, cannibalised and then typically it sits for years in some warehouse until someone is waking up, and then oh, we need to auction it off, and then the auctioneers that are used for the auctioning are not any specialists when it comes to e-waste, and it's a free for all, and we know that a lot of the mismanagement of e-waste is actually attributed to the way currently government as it's a written off, and the type of people that get access to it."

P3ES: "...but I think our government has greatly busted the idea of what an EPR could look like, the whole idea that, you know, you call it a levy, it's supposed to go to treasury, for me it is a systemly veiled attempt to just obtain money, ill gotten money without transparent feedback and, you know, if the industry is lucky, they can get a small percentage, but that is just another way to raise taxes,"

P3ES: "I mean, it's not that we don't have any recycling systems in place, you know, and if the government now tries to replace them, and shut those down in lieu of non-transparent unaccountable systems, I would walk away as a producer, and from the discussions that I had with our manufacturers, they have been very patient, and the thing that nothing happens in South Africa, I put the blame firmly on the government and not on the obligated parties."

P3ES: "The industry need commitment from our government and this money is their money, and they can actually spend that money for the intended purpose, and it doesn't look like this right now, it look like this is utilised again as piggy banking on all kind of other things that the government hasn't delivered on, including job creation."

P3ES: "No, you see that is obviously not what we want. We don't want SARS, because anything that is collected by SARS never seems to see the light again, but the numbers, we need the numbers, we need to know the numbers of the customer codes, we need the import volumes"

P3ES: "...the way it works with government, is they're equipment gets devaluated, cannibalised and then typically it sits for years in some warehouse until someone is waking up, and then oh, we need to auction it off, and then the auctioneers that are used for the auctioning are not any specialists when it comes to e-waste, and it's a free for all, and we know that a lot of the mismanagement of e-waste is actually attributed to the way currently government as it's a written off, and the type of people that get access to it."

P3ES: "Yes, we would call it ... ja well, the moment is, if we call it tax, there are implications that by constitutional, that's at least what the DA tells us, that it needs to be going into treasury, and that is an avenue that we don't want."

P4ES: "The last thing I want to say was is if government does take over the reins of funding, and often what happens is the industry believes that government is using these EPR systems to gain more money into their coffers, and whether it's for their own personal sort of use, or if it's actually for the country, the problem is that it has to be ring-fenced, and if you want to make a system work correctly, you can't have inefficiencies of money leaving the system and not actually going into try and keep it alive."

P4ES: "But that's the role of the actual government, they should be owning things, they shouldn't be making a profit or making money from things, but the problem is is that as soon as they control it, then it goes into the coffers and distributed beyond why you collected the money."

P5GA: "...with government there are other priorities, there are political priorities, we've seen, and I don't even mind if it's quoted, that the only people that's getting extra funds than the normal grants and stuff going to the municipalities, is the ANC municipalities in this province, the rest don't get it."

P5GA: "...the national department of environmental affairs has taken a decision that these things will be all handled by government, it will go into the viscus, which is a big problem, because it will not be ring-fenced, it will disappear"

P5GA: "So, the thing is, it's very difficult for industry in getting those funding, the imbursements is very difficult, so I believe that it should be run by industry, and that government should play the compliance marketing role. If it's done by industry it's much easier to get it out, and with the REDISA example they say this is why it shouldn't be handled by industry, but on the other hand, plastic bag levy, why did government do that? They fumbled totally. So, then it shows that they should also not handle it. So, I think in both examples, it would be a bit of a problematic, because it's the first time that it's implemented in South Africa, we must learn from that, and we must write very strong, or put in very sort of checks and balances to make sure that it's happened. It stays within the industry, it's easy to disburse it, and to getting it going, because once it's gone into the viscus you're going to struggle to get it out, and it will not be ring-fenced."

P5GA: "For me it's a bad thing [Referring to the Waste Bureau introduced by Government]. I think it should stay with the producer, and through that PRO it should be managed and you should have that direct relationship with the consumer, that you're paying towards something, and then you at least get some sort of, that you're feeling you get some sort of benefit out of it."

P7GA: "...government didn't show the best example, the industry, the only plan that we approved, they didn't do a very great job on their first attempt. So, there's an issue there, there's no denying it."

P7GA: "I mean, we're talking finances now, and the current situation is that anything that happens from any PRO, is going to go via the Waste Bureau. So, they're going to decide where the money goes, I'm not sure whether that's a good or a bad thing at the moment."

P14RDE: "The environmental impact, the hazardous impact on ... So they don't see it at all. I think the only time the government will actually do anything about it, is if they see there's a financial gain for them, which shouldn't be the thing."

P20SCM: "No, I don't think so." [On the question if Government should take control of the funds and other functions].

6.12-Theme 5-Producer Responsibility Organisation (PRO)

6.12.1-Producer Responsibility Organisation preferences and functions

-In favour of a PRO steering the system

P1ES: "It has to be the PRO. The PRO has to be the visible component of the system. The PRO needs to take the ultimate responsibility for it, but the PRO also needs to be able to have a handle on accountability and responsibility back to the waste bureau. They're not getting the funding, they need to make projects happen, they need to apportion blame, they can't be the blame and you know, that said, we're not putting in the right structures and facilities and everything else. They're not getting any money from government. So that level of accountability has got to come back, but the public face of it has got to be the PRO."

P1ES: "I mean, the concern is literally just the non-ring fencing of those funds, but the systems and structures I think, right through an industry related PRO, or through a waste bureau linked PRO is the right way to go."

P1ES: "I think it needs to be managed by a PRO, a PRO would sit under the waste bureau, and that PRO would be controlled by industry, whether that is your suppliers, your retailers, your OEM's or whatever, they will sit on that Board to make sure that the moneys are spent properly and that there's no anti-competitive behaviour. So yes, I think that component absolutely will work, but it's got to be run properly."

P2ES: "So if you look at Europe, so the WEEE standard, and that's a good standard, but why it's been so successful is they currently have 32 PRO's, so in each country there's a PRO, in some countries there are two, in some countries there are four, but they're all now whiffed and merged into one, because jump to the other end, the more successful you become at managing the waste, the less sustainable it becomes. Why? Because the volumes are increasing, but the cost per ton decreases. So therefore, the money paid becomes more and more competitive, and less for the recyclers to recover. So that's why those systems are coming to place, but at the end of the day they've got these PRO's, and they work well."

P3ES: "The PRO should be the guys that do this, in partnership and with support of advisory groups. So as I say, we as a "member of XYZ group" has taken the first steps to develop for our members some kind of minimum norms and standards, you know, of saying we have a code of conduct for our members, I would love to go to the PRO and say here is our code of conduct, please look at what is useful for you, I'm doing work right now with Switzerland, we're developing just now guidance principles for the responsible recovery and management of secondary metals. It's set to become an international standard. So I would like, as an individual, to have a chance to show them that and say listen, you don't have to reinvent the wheel, the world is doing it already. So ultimately it needs to be that, yes, obviously the supervision of the adherence of the standards, that is the role of the government"

P4ES: "It's interesting, because if you have the warehouse situation, it can't be a private sector, it has to be the PRO to make sure that everything gets there."

P4ES: "I think it should be a PRO, with a large emphasis on awareness, particularly around ... it has to be a psychological awareness, not just like traditional media, it has to be subliminal, it has to be by the right people, it can't have any political undertones to it, it has to purely be driven by a ... and a PRO should be industry driven, but that would come up just now."

P5GA: "They should have a system in place, I call it the PRO, product responsible organization. They should have this, and they should work that out, how the logistics will work. REDISA just started the fit, but they didn't do a good job, but they've learnt a lot since then in South Africa, and not how to do it."

P5GA: "So, if now a producer is already putting a system in place, they can track it, there's a way of getting it back, then you in actual fact, you as the consumer pays for it, and they make sure that the logistics is sorted out now, that there are places that's set up and built where they can take it in"

P9GA: "It should be the PRO, that's what the PRO is there for... It's supposed to make sure that whoever is the manufacturers, are part of this particular scheme, they contribute according to what they're supposed to contribute financially, and that they run the entire system, in one way or the other. If people have to be paid a sum through them...that's why I said we need an impartial person who's not going to be bias towards one grouping of stakeholders, and you know, not only bias to recyclers, or to transporters, or to collectors."

P9GA: "We need quantities, so the more we collect, the better, because some of them are not valuable. So yes, I support the PRO, but I don't support that we must have different types of PRO's, although I do know that the government intends to have plans for lighting and for the other e-waste. Lighting is also a category of e-waste."

P10GA: "I think they should do it [Referring to a PRO], but I think they should be regulated, there should be a regulation, maybe through the government, that this is how you should do it, they should have something that guides them, because if it's not regulated, then chances are they might do whatever they want to do, and at the end, you know, they end up, you know, the organisation just disappearing"

P12GA: "Ja, the way I see it is that ... I'm not an expert on EPR systems, so I can't prescribe how this thing would look, but I know that there had been e-waste take back programs in multiple countries in the world, and I think that there can be some lessons learned in South Africa, from those other systems, to say okay, we need a low tech system which is not going to be fraud with administrative hassles and that type of thing, and I mean, there must be lessons learned from other research that's been done in other countries on take back systems. Personally I think that a producer responsibility organisation is needed, and they need to manage the funding for the system, because if it goes into SARS, we're never going to see it again, I know that's what government wants to do, national government, but I don't agree with that, I think that the industry should run that and that they should be reporting to government in terms of their recycling rates and targets in terms of that."

P14RDE: "I think a PRO would be actually be a phenomenal idea. Once again, we need to have viable corporates, or viable bodies, if you can put it that way, to steer these, to steer these PRO's and to educate the PRO's and to make them aware of this is your responsibility, this is your legal obligation, however, these are the legal implications as well."

P14RDE: "So you need to have a ... into the National Environmental Waste Act, that we would have to implement a new law and a new bylaw to facilitate these PRO's, and to make them aware of, if you transgress, this is what will happen. So you need to have your ducks in a row, so that you can offload and function fully as a PRO..."

P14RDE: "I think the PRO's, giving with how serious a lot of large recyclers like us takes this matter, I think PRO's would be a phenomenal idea, and I think they will be able to steer something like this, to make it work."

P14RDE: "Yes. I think maybe just for the steering of an initiative like that would be phenomenal for them, as you said, you have to get your hands dirty somewhere, so for them to steer it will be fine, but for the initiation and for the safekeeping and safeguarding and for the transporting and things like that, it should run from government and to manufacturers, re-sellers, and your financial institutions like I said, but PRO's, to steer it, and to supervise it, and to check it, would be perfect. I'd say to referee it, but not to play in it."

P14RDE: "The only thing is, your alliances might have the legislation on their side, but that is about as far as they will go, you know, with your PRO's, your PRO's can be motivated to steer and to generate more awareness to generate more income. At the moment the ... you know, your alliances aren't doing much with creating public awareness with regards to electronic waste."

P16RDE: "South Africa needs its own model, but I think you cannot mimic it on someone else's, but you can start off a base and say okay, this won't work there, the collection model there, we've had problems like REDISA so that money was all collected, everything was done amazing, the marketing amazing, but no solution."

P16RDE: "Ja, definitely I think PRO do work. Sometimes they made them, but it needs to be balanced, you can't make them too powerful"

P18RDE: "Ja, I definitely think so. If we look at "Recycler A" for instance, you know, if it wasn't for their involvement then what will happen? If nobody cares or does anything about it, if it's not for organisations like the PRO, that motivates and boost and make sure that the things happen and that there's eye's it ... people won't just care, it will just be part of your normal waste and you know, it will just get dumped. I think it's important, we do need organisations like them, which makes it difficult sometimes, like they're non-profit organisations as well."

P19SCM: "I think PRO's is the given vehicle for extender producer responsibility. When industry would have some say in terms of the setup."

P19SCM: "We believe also that a PRO system can work, if the registry function is outside of the PRO, but then the PRO should not go out on tender, then it should be an open process. The PRO should say, if you're a recycler, you are legally licensed and registered, in terms of the company law, and you're meeting the recycling standard in terms of your collection practices and in terms of your transport practices, and in terms of processing your next tier. If all of those boxes can be ticked, we should not be denying a recycler to participate in the system. So we believe that a PRO should be working with 5000 different recyclers."

P20SCM: "I'm just thinking about it. Maybe it should actually be closer to the trade, as you said on the plastics, the manufacturing or whatever. In e-waste, or in my trade, appliances you might have a ... I'm not even sure, I don't think we've got an appliance organisation in this country."

-In favour of single PRO stream

P1ES: "No, there needs to be one, and I think we also need to classify what is e-waste. So at the moment we look at the issue that they are now trying to substantiate a different PRO for the lighting industry"

P1ES: "When I look at a system where lighting now falls under its own jurisdiction and all sorts of bits and pieces, but it's a critical and key integrated component of the e-waste cycle. So I believe that should all be under one PRO, but under that PRO you would then have divisions that would look at your white waste, your e-waste, your ICT waste, your lighting waste, and the new one that's coming up is the solar waste."

P2ES: "And the reason why I say one, whichever that one might be, is that the size of our market, we think it's a big market, but it's not big by any standard, it's actually a small market. So if you have a whole lot of PRO's, I think you'll create confusion, I think you're going to create unnecessary competition, which will drive pricing to a level that doesn't become economically sustainable. It might sound like I'm contradicting myself, but I've told you earlier on about a monopoly. The PRO is not a monopoly; the PRO is an administrator around system. It doesn't control the pricing."

P2ES: "The OEM is actually controlling the pricing, because that's why they sit in this registry separate to the Board of the PRO. They know what they're collecting. They know what it cost to recycle their products, so that's the check and balance, because they would make from that grouping, they would make a recommendation to the PRO on an annual basis, yes the fees are still fine, or no, we need to adjust them. Once again, from a PRO's point of view, you also want to check and balance to ensure that this doesn't become GUPTASIZED for example. So that's the checks and balances that we're putting in place. That's why I think a PRO is good. For the size of our market, it's a good thing"

P3ES: "...but I do think for the time being, in terms of getting going, and getting it right, and just seeing how bad it looked out on the tyre PRO, you know, to say let's have one first, and get this really right, but build this PRO, perhaps with an understanding that whatever the first PRO is representing, already representatives of distinct types of electronics that should form ultimately in a phase two to their own PRO's. So in my mind the first PRO should be an overall WEEE PRO, but you should have distinct positions of someone representing the white goods, someone representing the brown goods, someone representing ICT, and one representing lighting. So they should form part, almost like sub-internalised in that first kind of initial PRO"

P4ES: "...but I think it's very difficult with electronic waste, because it ranges from large ... from a kettle to all the way to like a super computer, so I don't know. What you might find is that there's the six categories that I was talking about, the large appliances, small appliances, you have IT, maybe it's about splitting those into separate ... like silicone versus non-silicone, or batteries versus ... I don't know, you'd have to separate the two, one to being very much less hazardous, and the other being more hazardous, I don't know if that makes sense, and so if it's IT for example, or chip technology, you should have a chip technology PRO versus a general of electronics."

P5GA: "...I think definitely it should be a separate group [from other waste PRO's], because it's so diverse as a group."

P5GA: "You see, if it's too much [referring to PRO's], you're going to sit with a problem, but if you throw everything together, you're also going to sit with a problem."

P7GA: "Of which I agree. I think it must be separated, if I have to suggest how it would be separated, it would be ICT waste, white appliances and lighting."

P9GA: "We need quantities, so the more we collect, the better, because some of them are not valuable. So yes, I support the PRO, but I don't support that we must have different types of PRO's, although I do know that the government intends to have plans for lighting and for the other e-waste. Lighting is also a category of e-waste."

P9GA: "I honestly don't think it's necessary, unless you're saying there's one PRO who then subcontracts smaller ones for other categories that are in smaller quantities, you understand? But for you to establish another PRO, you know, ja, I don't know, but I mean, obviously business would differ with me. Some of them would say no, we want more than one so that we can be able to share, but I don't think so, because eventually, if you have different PRO's, right, how am I going to understand how it all works?"

P9GA: "And that is already a concern, by the way, with people who are saying you want an EPR for paper and packaging, we want an EPR for lighting, we want an EPR for e-waste. I'm affected by all of them. It means in other words, I'm going to belong to all of these EPR schemes. I'm going to have to contribute to all of these PRO's."

P9GA: "Ja, exactly. So I'm going to pay for the packaging of my electronics, and then I have lighting within my, whatever electronics that I bought, so I'm going to have to, you know, the costs, is it triple the costs, do I belong to one, do I subscribe ... you know, those are the questions that are there, and ja, that's why I'm saying, in my opinion, maybe not, while we can have one. The minute you say there are many, I said oh, okay, it's going to be costly"

P10GA: "I think it should be one, because if there are a lot of them, it's going to be maybe a bit tricky to manage them, and some will, you know, won't be able to see who is lacking behind. So, but then, if it's one, I think it's easy in terms of management..."

P13GA: "Once you start defining, fragmenting that much, you lose the essence and the value of it..." [On the researcher question: "What is your view on a PRO?"]

-The PRO should involve many parties

P1ES: "Your key stakeholders. Your PRO has got to comprise a number of different people, so I mean, if I have a look at what I would consider an ideal PRO, it would be, you would have your retailers, your distributors, your OEM's are a critical component of that, you would then have importers as well, but then you also need an NGO, somebody with a non-vested interest who's in there representing the public. You need to have a representative from the industries as well, so that you have somebody from the small-scale enterprises and somebody from the large scale enterprises, so that all interests are represented in that PRO, and that decisions are jointly made by that PRO, and approved by the waste bureau, that make sure that there isn't any anti-competitive behaviour and that sort of thing, so you've got to have full stakeholder participation in there. I don't think it's at the stage where you need your public and that, because it then just becomes complicated."

P1ES: "So you almost need to have sub-divisions within that, so you almost need to have one person representing all the retailers and one person representing all the importers, otherwise it's going to become too cumbersome, so they almost need to have like an importers' meeting, and then you have one individual who represents the PRO, otherwise it's going to become cumbersome and things will get tied on the decisions that are going to be made."

P1ES: "If we don't do it with a level of transparency and accountability, we're selling ourselves up for hiding, and we need those people without invested interests, so someone like an OUTA or a Safe South Africa would be an ideal component having it, because they're looking after the best interests of the community, they have not vested interests."

P3ES: "...you should obviously have producers as the obligated party, that also represent, you know, all those kind of potential waste streams, and also recyclers. The question is, non-profit organisations, I mean, ja would they play a role? I tend to believe that the PRO is really all about obligated parties, and I'm a big fan about saying that it should represent the entire value chain as well. So we should also force the retailers as a ... or a retail association. So we're not talking ... I think the trick would be in this PRO to have members that are always representing an association."

P3ES: "I think yes, absolutely so. Perhaps again we need to look at, not just like a "rahhrahh" non-profit organisation, but someone like ... or for example voluntarily industrial organisations, I would like as a "member of XYZ group" [position mentioned but removed for anonymity] perhaps not be part of the PRO, most certainly don't want to be paid as a member of the PRO, but I would like to be able to be invited, or to give input, or to be a kind of a watchdog of the PRO. So perhaps they are not part of the PRO as such, but they would be afforded transparent insight in the activities. I would very much like to see that. I would like to know that OUTA can anytime have insight into the books of the PRO, that Groundwork South Africa, or you know, any of those grassroots organisations could actually ask what are you doing with the money? Okay, or if there's any scandal evolving of people getting poisoned because of mismanagement of electronics, that they could hold that PRO to a certain degree accountable, ja absolutely."

P3ES: "Okay, so not perhaps in the daily management of the PRO, but perhaps we need to look at different ranks, so you have PRO, they are literally managing the affairs, and then you have stakeholders, a white house circle of stakeholders that are interested, and that includes watchdogs, that includes specialists advisors as well."

P9GA: "They appoint a certain company to run the entire system for them, but within their scheme, you have all these players. You have your manufacturers, you have your producers, and within there you have your importers, because some of the producers are importers."

P9GA: "Some of the products, I mean the importer, you've got your retailers, you can even have your recyclers there, your collectors, everyone who's involved in the entire value chain....Should be part of it, but the PRO can be anyone, it doesn't have to be anyone of those categories of people that are mentioned, it can be anyone. They can appoint an independent company to run the whole thing for them."

P10GA: "I think it should be an NGO, and it should have a Board, the Board should comprise of different people from different aspects of areas."

P10GA: "Such as the PRO's maybe, and maybe environmentalists ...yes environmentalists...It should include ... everyone should be part of this."

-The PRO should be independent

P1ES: "In an ideal world I would prefer a PRO to be self-standing, without government involved."

P1ES: "Essential to the outlook of this entire thing for the industry, is that that PRO needs to be the responsible organisation that is educating the public and the payer and everybody as to what is happening, so that people can see the real stuff happening on the ground. We need to be able to quantify the waste streams, we need to be able to benchmark that on a yearly basis, showing how we're increasing, show what's happening, how many jobs are created, how much value had been put back into the country, and that information needs to be accessible to anybody who demands it. It's got to be publicly available information."

P1ES: "It has to be the PRO. The PRO has to be the visible component of the system. The PRO needs to take the ultimate responsibility for it, but the PRO also needs to be able to have a handle on accountability and responsibility back to the waste bureau. They're not getting the funding, they need to make projects happen, they need to apportion blame, they can't be the blame and you know, that said, we're not putting in the right structures and facilities and everything else. They're not getting any money from government. So that level of accountability has got to come back, but the public face of it has got to be the PRO."

P1ES: "But if nobody ever audits them, nobody ever, you know, says well, you know, what are you doing with nature?? or with this or these hazardous products, there's no control, there's no oversight, there's no management. That has to be structured, where that PRO needs to be given the powers to be able to shut down a system. If somebody is not in compliant, they need to be able to issue a notification (not the word but the Same meaning) immediately to close that facility, and that power has to be there, but that's where our PRO structure is very important to make sure that it's there to service the best interest of the industry, and not the interest of the few."

P2ES: "Proper PRO, completely independent, nobody can have any direct or indirect dealings to the actual recycling industry, and you have a system that says okay, this is how it's going to work, this is the collection points, there's a registrar and everybody has to register to be part of it, so there's no free riders and fly by nights, so the system is taken care of, and then in each of the centres throughout South Africa, you have the collection points, you have the murfs?? and I think it's going to work."

P2ES: "In each country there is one PRO, that is not for profit, they're not involved in the recycling business whatsoever, they just provide the management and they manage the process from a governance perspective, and I think that's a good thing, so you want to keep the things separate, then in this country particularly you need proper governance, you need a system that's independent, that actually delivers on the drop"

P2ES: "Okay, so in terms of the Board, as I've mentioned, I can't stress this enough, it should be completely independent"

P19SCM: "The problem comes in in terms of a PRO, and I think this is currently developing throughout the continent, everybody sees the PRO, but they want to put too many functions within one umbrella."

P19SCM: "You cannot run a referee function and a beneficiary function in one body. You'll always end up with conflict of interest."

P19SCM: "And I think that's where we see, you know, the thinking in terms of the referee function when it comes to the PRO, is very problematic. The advocacy, the lobby work that our industry, or the ICT industry has been doing, is to really get government to put forward a framework that industry could come up with a plan, and a plan that is fair, a fair level playing field for the obligated party, a fair level playing field for the industry that needs support...through the mechanism of extender producer responsibility. But the referee function in terms of ensuring that fair level playing field need to sit outside of operations"

P19SCM: "And to support the establishment and the growth of the recycling industry that needs the assistance. So PRO, although it sounds good, very problematic, because we want to put all of these functions, we want to put it all under one roof."

P19SCM: "It's also problematic when a PRO, where there would be one PRO, it would have a referee function, and then typically would maybe only contract recyclers through a tender mechanism, that is a monopoly setup... It's not conducive to competitiveness, it's not conducive to growing the economy in a global manner, and it can then be also very costly."

P19SCM: "A PRO need to support and look after the industry. Once again, it needs to be an autonomous, not for profit body. It needs to assist government, all of the government needs assistance in terms of enforcement, or specific industry, or it needs to have oversight, and the core function of a PRO is in terms of the financial mechanism, which is core, the extender producer responsibility financial mechanism for end of life, is to perform the collection, obligated collection, fair collection from the producer principle and to do disbursement in the correct way"

P19SCM: "No, I think there we need to be very clear, I mean, there we need to get water in between, you know, the function. So I mean, if in terms of the management of the PRO, the management of those referee functions, you cannot allow those management functions to also be sitting in industry and to be running, let's say maybe a recycling operation, and then over the weekend I get to make the rules."

P19SCM: "I think what we're saying with the PRO, it's just the referee function should be completely separate from the industry itself."

-The need for a Registry

P1ES: "In an ideal world I would prefer a PRO to be self-standing, without government involved. The problem with that becomes the same issue as you now face with current PRO's, like Polico and Petco where only certain people are paying money into that, and that just leaves a whole bunch of guys out there who now have a market advantage, because they're not paying that EPR, and so there's positive components to both sides at this story. I mean, the concern is literally just the non-ring fencing of those funds, but the systems and structures I think, right through an industry related PRO, or through a waste bureau linked PRO is the right way to go."

P2ES: "Proper PRO, completely independent, nobody can have any direct or indirect dealings to the actual recycling industry, and you have a system that says okay, this is how it's going to work, this is the collection points, there's a registrar and everybody has to register to be part of it, so there's no free riders and fly by nights, so the system is taken care of, and then in each of the centres throughout South Africa, you have the collection points, you have the murfs?? and I think it's going to work."

P2ES: "That's the categories, this is the recycling fee attached to each category. We know why, because part of our plan is to have a registry with all producers, importers, distributors, i.e. anybody that's making or selling or distributing a product, has to register. At the beginning of each year they say I'm predicting this year to sell a thousand cell phones, five hundred laptops, based on that we now know what the obligation is."

P2ES: "...we're busy developing software that will be a further check and balance. Every bit of waste that comes into the system, because everybody has to be registered, whether you're a collector, one man waste picker, to a hundred billion recycler, you have to register on the system, and any money that gets paid from the fund, is tracked and traced, and is audited by independent auditors. In addition to that, we are training and developing auditors to go out on a regular basis to audit facilities without notice. So from to auditing your recycling point to auditing your collection point, once again, just to make sure that things are transparent."

P3ES: "Setup with management of a registry to capture register, again I think that would fall onto the thing of a PricewaterhouseCoopers, because they will get the data from SARS and ITAC on import levels,..."

P8GA: "So, if we actually have a system in place, it needs to be then go to register people, and only it can then be distributed to that people, and not as an individual that come in and buy and I actually go back door and actually disassemble it and actually, you know..."

6.13-Theme 6-Take back scheme & reward system

6.13.1-E-waste reward system to discourage hoarding

-Consumers are hoarding e-waste

P1ES: "...so people hang on to stuff because they spent a lot of money on it, and the reality is is that it's worth nothing, it's worth nothing in their hands, but if it goes through a proper system the value can then be unpacked. We're going to try and educate people of the fact that they need to do the responsible thing, I mean for every single individual to try and recycle their own computer or whatever, they're not going to make any money out of it, but a sole separation program needs to be tagged with a different component as well."

P3ES: "So where is the stuff? Very simply, it is still at the households. So we went actually to the townships, and I had a guy who speaks Xhosa, and he was ringing on the doors, and we had this very grassroots exchange of information of 'do you have at the moment phones?', 'do you have at the moment a computer?'. Yes, yes, yes. 'What would it take for you to give it away?' and it was very clear that people said they want something in return, and no, they don't care about a tree that gets planted, I mean, that was one of the things that they did for example in Sweden. So people have a higher income class, they can afford themselves the luxury of environmental consciousness, for them it's good enough to know that they're planting a tree on their behalf when they return their equipment"

P3ES: "Data, and that would, in my opinion, very, very much unlock and unblock the return of e-waste. If that's not happening, it's not going to help them"

P4ES: "I think in Europe that's happening a lot, particularly with things like cars and washing machines and TV's and that sort of thing, we're kind of doing it already with cell phones, the problem with cell phones are that we get to keep it afterwards. What happens with people is that we're very sentimental, and we want to keep it, because we think we're going to need it at some stage, or pass it down to someone, but we never get rid of it,"

P4ES: "...with the Mintek report, one of the biggest issues that they've had, is not gaining access to large volumes and e-waste, because people just like hoard them, but if you become a regional player, then you can get large volumes."

P16RDE: "I think the reward system works really well. I think going back to the deposits on bottles and that, and it does work. So a lot of its marketing to ... like with encourage trading values and that, and it definitely works, because people have a sentimental value to the e-waste, and that sentimental value needs to be broken, maybe with marketing, and that's what those reward programs do, and stuff like that and it does help, you've got to break that sentimental thing, that you're going to use that product one day and it's valuable now, which is not anymore,"

P19SCM: "If we make that informed decision, there's a better likelihood that we could be passing on value to that household, to that end-user. Number one, if there's potential for me to get a little bit of money for something, I'll be more encouraged to take it outside of my garage, or where I'm stockpiling it."

P19SCM: "Ja, it's essential. It's really essential [Referring to a reward system to encourage consumers to return household e-waste items], and it's essential for a number of reasons. Number one would be to then also assist your household or your end user to clean out, you know, to get rid of the stock parts."

P19SCM: "There's potential value that can be unlocked. Through EPR one can realise that value superficially, but I think in terms of human behaviour, consumer household behaviour, you know, we all get attached to something, and I think people get a lot more attached to electrical and electronic devices, compared to other waste streams, compared to my drinking bottle, my water bottle."

P19SCM: "But it should be very convenient, it should align with the consumer or the household members' daily activities, daily commute, weekly, you know, visiting family, it should just fit into the lifestyle...and I think then you're going to ... then you're going to stand a better chance to unlock, you know, stock piles, currently, in their households."

P20SCM: "And a lot of times, this washing machine ... and when they get their new washing machine they say okay, where does the old one go? Oh, the garage."

-Implementing a reward system

P1ES: "I think that would be very difficult, because you know, there's no real reward system anywhere else in the world. You're dealing with a different system where people are looking at social responsibility in terms of doing these sort of things. Even where we look at the first world where they have deposit type systems on bottles and things like that, it hasn't really worked that well....What it has done is it's helped the poorest of the poor who were quite happy to pick up somebody else's bottle and make more money out of it than they would out of recycling."

P1ES: "So that kind of reward system can work, and it has been shown to work. The problem then becomes then as soon as they then realise that, you know, they just pulled out the copper out of the system, there's way more value in just the copper they can get out of the system, so then you end up with the same problems coming through. A reward system would work, and I think it would probably help particularly getting things kick-started and helping to spread information and education. I wouldn't support a reward system. It comes at all sorts of different problems. I think particularly when you look at a country like ourselves with a wide diversity from a LSM perspective, you know, how do you manage something in a rural area versus a little city centre, because it's very different dynamics that's going to be at play"

P1ES: "And unfortunately when you look at the lower LSM issues, they want immediate gratification, and whether it's just to get the food for the day, or whether it's to buy the next hit of Wonga, or whatever it might be, the guy at the metal merchant doesn't give a damn."

P2ES: "So people need ... a program needs to be put in place for that awareness to be made, and for the incentive for people to start separating at source. Why? Because as we all know, landfills are a big issue, and I'm not going to get into that now, there might be a question around that later on, but if you start separating at source, everybody benefits"

P2ES: "So the consumer will benefit, the municipality will benefit, and the benefit that flows when I say the consumer, the municipality should be able then to start reducing their utility charges, because waste is handled in a different manner, which reduces their costs. It reduces the landfill costs, so therefore they don't have that costs, they should pass some of that incentives back to the consumers. That's my view."

P2ES: "...and there's lots of mechanisms which you can use to do joint promotions and encourage people to take their old fridge, or their old microwave to a retailer, and exchange it and get an upgrade at an additional price to the higher item. That way you have some control over this reversal logistics process"

P2ES: “Ja look, that’s a contentious point by most people’s view, for me it’s not contentious. If you don’t do it, it’s not going to happen.” [On researcher question: “What is your view on a reward system to encourage consumers to return household e-waste items”]

P2ES: “So the old school people, like the baby boomers, like ourselves, we find it more difficult to make that change. If you take the millennials now, they are very conscious about the environment, so they are more prone to do it, but right now they make a small percentage of the economy. So to ensure that people do the right thing, if you make it easier for them, or there’s some incentive, and the incentive doesn’t always have to be cash, there can be many other forms of incentives, then you’ve got a higher chance of success, and then after time it will change behaviour, and then you can start cutting back on those incentives, once the behaviour is in place.”

P2ES: “So once again, just a culture, but it takes time to get there, and we must accept that we’ve got it, and we have to say to ourselves, because a default response is, our culture won’t allow it. Well, if everybody keeps on saying that then it won’t allow it. You don’t start making a change, and if you use some incentives to encourage the change, then I think you can change behaviour.”

P3ES: “...but I think in the context of South Africa, there should probably some incentive in place. It will probably not work for people to bring back without any reward. So there should be some money of the EPR funds, that will create an additional incentive, but still, there should be a firm legal request, a firm legal requirement that household consumers must have to bring back, and that needs to be in the legislation, as part of a valued chain of e-waste consumers”

P3ES: “ ...but I think there is a huge opportunity with mobile collection units, and if you look for example at the packaging industry, they just started now a pilot project called “PACKA-CHIENG”, where they have actually a mobile solar driven thing with a scale and actually with a baling unit that they take to the townships and then people can bring packaging waste, they have actually become undersigned with MasterCard, so people have a moneyless system.”

P3ES: “I think here in South Africa it would work very well either with a discount on the new equipment, or in my opinion, even better with airtime.

P3ES: “So where is the stuff? Very simply, it is still at the households. So we went actually to the townships, and I had a guy who speaks Xhosa, and he was ringing on the doors, and we had this very grassroots exchange of information of ‘do you have at the moment phones?’, ‘do you have at the moment a computer?’. Yes, yes, yes. ‘What would it take for you to give it away?’ and it was very clear that people said they want something in return, and no, they don’t care about a tree that gets planted, I mean, that was one of the things that they did for example in Sweden. So people have a higher income class, they can afford themselves the luxury of environmental consciousness, for them it’s good enough to know that they’re planting a tree on their behalf when they return their equipment”

P3ES: “...data [Referring to airtime data], and that would, in my opinion, very, very much unlock and unblock the return of e-waste. If that’s not happening, it’s not going to help them”

P3ES: "Yes, all of those, and you know, there are so much of this mobile money systems already in place, you can actually plug that in into mobile moneys and even things like Shoprite has this counter, you know, where you can pay your electricity and your water and things, so you could actually ... as I said with 'PACKA-CHIENG', where they have an underwritten thing with MasterCard, so that people bring their recyclables, they get measured there and then and it gets loaded on the card, there and then, they do it in partnership with Waste Plan apparently, so Waste Plan operates those mobile units, and then they can take this card and it's loaded, it's a debit card, they can spend it for whatever, and I think that flexibility is first price. Don't give them something they're not interested. It's a virtual amount of money on a debit card; they can choose what they want to do with it."

P4ES: "And might happen is, they might as Takealot maybe also, instead of giving you money, you get like credits, for Takealot, to purchase on Takealot."

P4ES: "So I think that would be quite a cool and interesting thing to play around with, to look at, instead of purchasing something, you rent it as a service, and then in terms of question three, I think a point system is quite interesting, particularly for pickers, waste pickers, because often what happens is, the waste pickers that are going through household waste on the side of the road will find stuff. Now the problem is, is that they don't really want to walk around with money, because if they get robbed they lose it. So there's a program that's been set up by a company called 'POLYCO', and POLYCO is a PRO for the ... for one of the plastics, and they set up a project where people could come drop-off waste, and then they get given money for it, but the money gets put onto like a Visa card, and it can be used anywhere as a Visa card."

P4ES: "But what you might also have found is that even maybe households can do the same thing where they can take it to a drop-off, and then the money gets loaded onto their credit card, or onto their debit card, or something like that"

P4ES: "Also what's interesting is data is often seen as a currency. So there may be an opportunity for data, instead of giving money"

P4ES: "I don't know if you'll remember, but you used to get these competitions at school whereas if you bought a lot of newspapers ... per child that bought the most newspapers, got a big prize. You can have the same sort of thing, and the cool thing about electronics is that it often can be a lot more valuable than paper, but that just needs to be a well-coordinated system, but I don't think it should ... it's interesting, because people think that waste is about making money, the problem is that they don't realise everything that's gone into a) getting it to you, and b) getting it away from you"

P4ES: "We always have companies that come to us and they're like 'oh, we've got all this plastic', and they want to make money from it, and then we're like 'hm, you're not really going to make it, because a) it's contaminated, it's not clean, and b) someone has to come and collect it, and sift through it and what not. So there's all these logistics costs and labour costs. So I think, I don't know what the reward would be in an essence, because it doesn't make financial sense to give people money, but maybe there should be a way of a social reward,"

P5GA: "Okay, it's not on a cash basis, but the things I've seen overseas, is that you would take it to a retailer and you would get credit to purchase something there. The best ways of using economic instruments in South Africa, was actually deposits. That's why you don't see a Coke bottle lying around, you don't see a car battery. So, that's definitely, I think we should definitely go towards that, if you want to get it back. See, if you're already paying when you purchase it, then basically when you're taking it back, you get basically that money which you paid, back, already there's a transaction there, and that will depend on how you do it. If you do it at the retailer, then you can do it like that, that you get a voucher, and you can purchase something. I think with the municipality, they will be hesitant to implement something like that, they would be definitely hesitant. Then it makes sense that it goes to a retailer and let the retailer handle the transaction."

P5GA: "...in South Africa, with our, how can I say it, prevalence of crime and stuff, you want to make it as that cash don't exchange hands quite a lot."

P5GA: "...so what I'm trying to say is, so interwoven with the business that the retailer is doing, it's when you take it back, you get your refund, because if you do it, and you now start banking on the informal sector to get it there, I think you've got a bit of a problem... So, what I'm trying to say is, you don't give it out to anybody, you take it back yourself, and it's controllable and it's a similar product that's been handled by that retailer, it's in his business of operation, and it's working."

P7GA: "...a reward system needs to be in place, but I'm just not sure, we haven't had any successful examples of that with our other waste streams, although, with the municipalities, I agree with P5GA: ", they might be hesitant, but I just feel like, at the end of the day, sometimes it always comes down to the municipalities, and they are always collecting against a budget that they don't have, so I think more thought maybe in that area, around how municipalities can get some better value for what they are doing, because they are doing all the services in any case."

P8GA: "...like where a recycling companies are currently developing systems where people then actually sell the recyclables, but they don't get ... they get like a bank card, and you know, they then receive credits on that card, and that card can be used to buy items at shopping centers and so on. So, if a system like that can be put in place, so it means people are not vulnerable in terms of walking with cash on them, and they can then actually take that card and then actually go and buy whatever they need."

P9GA: "It has precious metals, and I'm thinking, okay, I'm giving you my old phone, and what am I getting out of it? You're going to make money out of it."

P9GA: "I'm not sure. I mean it works to incentivise people. People really get interested if you tell them there's something in it for them"

P9GA: "So initially you might use it as a motivator for me to do that, but as to whether it's sustainable or not, I'm not sure."

P9GA: "So whether I like it or not, I will pay for it one way or the other...Yes, we as the consumer, we will pay for it."

P10GA: "Because in the rural area we don't just throw anything, we will keep it ... I don't know how many irons I have in the house, or at home, but they will keep it, they will want to go and sell it and get something. So in the rural area is an issue of job creation, you go and sell or you exchange with something, or maybe you can start a program to say bring all your electronics that are not working, in return we will give you a food package, or a vegetable package, you know, some incentive, but not for free, otherwise you're not going to get it. Else it will pile and pile, the next thing it's all over the landfill site.

P10GA: "So maybe something like a buy-back centre where I can be able to sell my iron maybe for a small fee, and they will dismantle it and make a living out of it

P10GA: "You know, the reward system that I think would work, it will maybe be the point system whereas, let's say for example I'm a residence, I take my e-waste to wherever, the garden site, I've got a certain card, every time when I get that e-waste, I get points, and then maybe after a certain period I can cash those points or go and get something whether at Pick 'n Pay, Checkers, wherever

P10GA: "...in all the recycling, you know, people why don't want to recycle, because there are no reward system. People will ask, okay, if I do this, what is in it for me? So that's what we are battling now

P10GA: "So I think for us, as South Africans, or as the nation, as the countries, we must start recycling, and the government, or whoever, must come up with a reward system that can encourage everybody to recycle, because at the moment there's nothing that motivates and encourage people to recycle, and also our collection services, if we say we will collect in this area on a certain day, let it be on that day, and let's come, because you'll find that today I put out my washing machine, you don't come. Do you think next time I'll recycle it? Definitely I'm not going to recycle it.

P12GA: "Ja, I mean, ideas like some kind of a discount on your new item and you come to the shop and you bring your old item, I think something like that can work really well, because it benefits the retailer, and the manufacturer by association, plus the customer, so it's a win-win for all. So in my opinion, systems like that I think could work really well, where it's some kind of a take back thing, not necessarily a deposit, but maybe like a discount on your new item, or something like that."

P14RDE: "There are studies, well there's a program in countries like Brazil, at the moment, where you can take your ... where they will come with a new machine, a new fridge, and you give in your old fridge, the same is like an exchange program, and you get the new one at a much less price at the old machine, and then they recycle the old machines for the new machine. So they recycle the old machine, but they give you a new one in hand for it.

P14RDE: "So what happens is, once a year we, all over the whole of South Africa, all your Hi-Fi's and Incredible's [Incredible Connection], for a month, they run a take back scheme, where people bring their old laptops and say listen, here's my old laptop, I'd like to buy another one. Sure, we'll take your old laptop from you, we will give you a discount on another machine for you. That will be a very, very good thing if we can implement if we can implement it 24/7, 365, that will be nice, and as I've said, it doesn't necessarily always have to be a monetarily imbursement, it can be other reimbursements as well.

P14RDE: "A reward system is the best thing that can ever come up...So my broad spectrum on that is I really feel we should do it, and it should start with the top and then work down on all the tiers and ... but you should have a corp(oration) then and once again we should have a responsible person or body to come and to make sure that everything that's taken place, has been adhered to and attended to

P14RDE: "Rather, if you want to go to the store, rather say to ... the stores would rather say we give you a card, a loyalty card, on your loyalty card we load you your credits.

P14RDE: "And then your credits, those credits then, at the end of the day, can be used for the purchase of a new item and such. Money is always a bit of a ... it's always a, you know, not the route of all evil, but money is a temptation tool,

P14RDE: "To also stir consumer spending in your store, and it will be more financially sound, or more viable for you to rather give your customer a loyalty card, but they can only use it at your store, it can't come to you, give you the electronic waste, and the customer ask for the money you've given them, at least you stimulate more growth in your shop and you stimulate the growth of your business as well.

P15RDE: "You need to create some excitement in it. Petrol, for example, is a grudge purchase. So if you make petrol stations with nice places to have some coffee or something like that, or gardens or water or something, so that you make some excitement or some attraction to it, yes." [On researcher question: Do you think it will help if people get some sort of reward if they hand in e-waste?"]

P15RDE: "It's not very much effort, and you can also, as an attraction, tell them that this is going to be recycled, and recycling is a good thing in South Africa, and you get like these cards that you would get with something, you know, like one cent in a rand that you get as a bonus for doing it, which is nothing, but it's excitement.

P16RDE: "I think the reward system works really well. I think going back to the deposits on bottles and that, and it does work. So a lot of its marketing to ... like with encourage trading values and that, and it definitely works, because people have a sentimental value to the e-waste, and that sentimental value needs to be broken, maybe with marketing, and that's what those reward programs do, and stuff like that and it does help, you've got to break that sentimental thing, that you're going to use that product one day and it's valuable now, which is not anymore, ...methods do work, and if it's something for deposits, if it's something for a trade-in value, I think they all work. Ja, I think they definitely all work... so again, the reward can vary, but it's a reward system and it does work.

P17RDE: "In essence, recyclers thus need to get some form of compensation to recycle household e-waste."

P17RDE: "Collection initiatives in rural areas are a major problem. We have addressed the problem by placing containers in rural areas where the community can take their e-waste and get some money for it. At the same point internet connections can be accessed at the containers, CV's can be printed etc. Refurbished laptop can also be ordered from these points and will be delivered to the purchaser. The whole purpose is thus to attract people to have a reason to go the containers."

P18RDE: “If you want someone to bring something back [Referring to e-waste], it needs to be rewarding for him, otherwise he won’t do it.

P18RDE: “yes, if you can give them a reward, like you said, for the appliance or whatever they’re chucking, then they would be encouraged, because how much fly tipping do you find in a place as well, even if they live in an urban area, they just sit in the car’s boot and drive around the corner and throw it next to the road, because they didn’t want to drive far, it’s costing them money. So yes, if you can pay them or give them something,

P18RDE: “If it’s something valuable to your more poor community, you know, like you said, mobile data or something like that, that they can use, it means something to them, it’s got value, then definitely yes, otherwise, no.”

P19SCM: “If we make that informed decision, there’s a better likelihood that we could be passing on value to that household, to that end-user. Number one, if there’s potential for me to get a little bit of money for something, I’ll be more encouraged to take it outside of my garage, or where I’m stockpiling it.

P19SCM: “Ja, it’s essential. It’s really essential [Referring to a reward system], and it’s essential for a number of reasons. Number one would be to then also assist your household or your end user to clean out, you know, to get rid of the stock parts.

P19SCM: “Number two, your incentive need to be coupled, need to be linked to the entire product, and there we could also then assist and it could help with equipment then being recycled in a rudimentary manner where it’s actually broken up. So if somebody, if the apparatuses are definitely dead and there’s nothing one can do with it, then ultimately, you know, there would still be, you know, a value then to make sure that all of the materials then go into a more controlled value chain, or stream, as to say.

P19SCM: “So I think it’s really essential [Referring to a reward system], and I think it’s a component that’s missing. It’s really ... it will provide the glue for the entire control system for the entire eco-system to really work, to be effective, and I think it will really help with cherry picking. I think it will really help with selective separation that is currently taking place.

P20SCM: “I wouldn’t say a Capitec card or something, its’ a bit more controlled and you don’t have cash floating around, and you can have deposits swiped onto a card, or we might even have the system where I think they talk about the Pezula’s etcetera, it’s certain places where they say alright, give me that card, with that card you can buy food and certain stuff at certain shops, so you might not be able to buy liquor for it, but your bread and milk, or clothing, could be bought from it.”

6.13.2-E-waste take back system

-Take back schemes

P2ES: “...and there’s lots of mechanisms which you can use to do joint promotions and encourage people to take their old fridge, or their old microwave to a retailer, and exchange it and get an upgrade at an additional price to the higher item. That way you have some control over this reversal logistics process”

P3ES: "Okay, the responsibility of the household consumers would be to take back where it has been bought. So I think that is a responsibility that should be legally enshrined, like for the retailer, the responsibility is to accept the take back, it should be a legal responsibility for the household to bring back. So the responsibility I would assign as to any household is to bring back, and that should be legally requested."

P3ES: "Ja, so bring back should be on different levels. So they should be able to bring it back to a retailer, or the base of this is where they bought it from, so, you know, there is a take back obligation on the retail side."

P3ES: "For large supplies, that is obviously a big one, I mean, you have a washing machine, or you have like a really heavy equipment, what are you going to do about that? I think this is where something like a business to business model would have to be expand, like if you look at HP, they offer like business to business take back systems, and something like this, I think the white goods association, I think that is something that they should incorporate as part of the EPR obligations, that they offer household collection, because otherwise those things are moving very hardly, difficult, from a logistic point of view"

P3ES: "It should happen [Referring to a take-back program]. I'm still myself in two minds on how much detail take back. I'm not sure myself if we should just first go with a big swipe, Pareto principle let's say okay, ultimately we want take back of all e-waste, but let's first crawl before we run, and let's look which is the most established one, which is the most easy to solve problem on e-waste, that has significant volumes, and I would immediately say ICT equipment. So I would like to see that perhaps we have a pilot project on the national take back of ICT equipment, evaluate that to a gap analysis, and then rope in other types of electronics, but possibly not through the same system, because the practicalities are simply not there, but the actual strategies could be extracted from that first take back system, ja."

P3ES: "Ja, that would be an advanced recycling fee where you actually buy an equipment and there is a surplus on your equipment and that is earmarked that you can return it for free after you're done with it."

P4ES: "Actually I do foresee a take back program, ja, it should be implemented by PRO's."

P5GA: "...we want to use reverse logistics, where if you buy a lamp, you can bring the lamp and in and take it out, or the battery. So, in that case, I think that can help quite a lot, and that can even help maybe with the poorer areas also, if you can re-use it, because you're not going to let the thing leech out there, so you're going to get it in and you take it out, so maybe that's a good thing if you start using, let's say the retailer that sells it, also must make provision for a person to take it back and to take it out."

P5GA: "..., so what I'm trying to say is, so interwoven with the business that the retailer is doing, it's when you take it back, you get your refund, because if you do it, and you now start banking on the informal sector to get it there, I think you've got a bit of a problem..... So, what I'm trying to say is, you don't give it out to anybody, you take it back yourself, and it's controllable and it's a similar product that's been handled by that retailer, it's in his business of operation, and it's working."

P10GA: "You know what, that one [Referring to a take-back system] also I think it would help, it should happen, because the producer should be responsible for the waste that they generate, but then how they should be managed, I think maybe ... because if we say that Makro should, let's say for example I buy a microwave and take it back to Makro, if we are saying Makro should manage that, I think in a way we are going to have a challenge. Their business is to sell whatever they are selling, their business is not to take back or manage whatever they take back. So maybe if we can have some entrepreneur to say in an area, you collect at Makro, you manage whatever is coming back at Makro, Makro they will just provide a facility where the residence can take back their e-waste, but we should have somebody, as an entrepreneur, to go and manage it so that maybe that person they can make sort of a living out of it, sort of a job creation"

P12GA: "...so if there is a recycling option available to them, where they are situated, they should use it, otherwise safe and responsible disposal. If there's a take back system, they should use it, ja, so I think it is their responsibility to just protect the environment in how they manage that waste."

P12GA: "Ja, I mean, ideas like some kind of a discount on your new item and you come to the shop and you bring your old item, I think something like that can work really well, because it benefits the retailer, and the manufacturer by association, plus the customer, so it's a win-win for all. So in my opinion, systems like that I think could work really well, where it's some kind of a take back thing, not necessarily a deposit, but maybe like a discount on your new item, or something like that."

P12GA: "Just another aspect on this whole thing is, is the aspect of the municipality enabling, or enforcing industry to use their systems, so to kind of create an enabling environment for take back systems, for industry to be required to take back the e-waste that they sell and all of that, and that is also definitely part of the playing field. I think it's still quite small in South Africa, I mean, I have heard of a couple of people that are taking back e-waste, but it's not kind of like the norm as yet, there is another ..."

P12GA: "Ja, the way I see it is that ... I'm not an expert on EPR systems, so I can't prescribe how this thing would look, but I know that there had been e-waste take back programs in multiple countries in the world, and I think that there can be some lessons learned in South Africa, from those other systems, to say okay, we need a low tech system which is not going to be fraud with administrative hassles and that type of thing, and I mean, there must be lessons learned from other research that's been done in other countries on take back systems."

P14RDE: "So what happens is, once a year we, all over the whole of South Africa, all your Hi-Fi's and Incredible's, for a month, they run a take back scheme, where people bring their old laptops and say listen, here's my old laptop, I'd like to buy another one. Sure, we'll take your old laptop from you, we will give you a discount on another machine for you. That will be a very, very good thing if we can implement if we can implement it 24/7, 365, that will be nice, and as I've said, it doesn't necessarily always have to be a monetarily imbursement, it can be other reimbursements as well."

P14RDE: "But yes, a take back scheme will be phenomenal, and it would be something that will really set us apart from everybody else in the world."

P16RDE: "Ja, definitely your outlets where you purchase the stuff, because that's the way to get it back, and the small offshoots where you can buy components for them, like repair modules, or something like that, recycling centres, municipality recycling centres. Ja, again I strongly believe in the guys who you're buying globes from should have a tin to take back your old one, and someone should be paying that, ideally the producer, because they know what's ... ja."

P16RDE: "A little reverse logistics. So when someone delivers the fridge, they must take the fridge back out, and like a battery component, lead acid batteries has got something very specific like that when they pay there, I think your deposit system is like R150 and that works really well, so ja."

P16RDE: "It goes back to ... there's Makro, or there's Builders Express, which sometimes had bins, some don't have anymore, some do. So ja, you go to them or you go back to where you were, because most of them would at least still have some kind of a solution what they're working with."

P18RDE: "With legislation it should be part of the law, because if you don't do it, then it will not be controlled, it can also become a mess, but yes, like you said, go back to your Games and these places and we can take it back, but yes, again, and I've seen that many times with programs like this gets implemented, you know everybody brings it, or the shop takes it back, but at the back of the store it just goes into the normal waste bin again."

P19SCM: "And the take back scheme sits completely separate from the registry."

P20SCM: "Ja, we basically always try to avoid it, to get an item back, because what do I do with it? So, in terms of if a client says, well, remove it, now I'm fortunate to have the service division at the bottom, with the workshop area."

P20SCM: "No, we don't." [On the question if the retailer has space to store e-waste].

P20SCM: "...because you can't work at a R100.00 or R200.00 a square."

P20SCM: "And as a small business, I'm already overloaded with all the statutory stuff, it just becomes too much."

-Take back should be part of legislation

P3ES: "Okay, the responsibility of the household consumers would be to take back where it has been bought. So I think that is a responsibility that should be legally enshrined, like for the retailer, the responsibility is to accept the take back, it should be a legal responsibility for the household to bring back. So the responsibility I would assign as to any household is to bring back, and that should be legally requested."

P3ES: "...but I think in the context of South Africa, there should probably some incentive in place. It will probably not work for people to bring back without any reward. So there should be some money of the EPR funds, that will create an additional incentive, but still, there should be a firm legal request, a firm legal requirement that household consumers must have to bring back, and that needs to be in the legislation, as part of a valued chain of e-waste consumers"

P18RDE: "With legislation it should be part of the law, because if you don't do it, then it will not be controlled, it can also become a mess, but yes, like you said, go back to your Games and these places and we can take it back, but yes, again, and I've seen that many times with programs like this gets implemented, you know everybody brings it, or the shop takes it back, but at the back of the store it just goes into the normal waste bin again."

P18RDE: "Ja, it's not happening. So definitely from the government's side, you know, legislation, it needs to be part of the laws, and there should be audits and that type of thing that there can be an audit trail of how it should be done as well, that you can track it and see what's happened to it. I mean, if you take something back you need to sign in a register that you've returned whatever, and that's the first step where you will check what had come in and then where did it go. You have to have proof of those things, that's the only way."

6.14-Theme 7-Proposed Auction house

6.14.1-Arguments for and against auction houses

-The Existing format of auction systems

P3ES: "Auction houses as they exist, are very problematic, ...it's a free for all, and we know that a lot of the mismanagement of e-waste is actually attributed to the way currently government as it's a written off, and the type of people that get access to it."

P7GA: "...if you get rid of stuff through a public auction, by a municipality, be it small goods or large goods, you don't have any control thereafter, so if once the purchaser gets it from the auction, and it's deemed unfit for use, or irreparable and stuff, it still then ends up back at the landfill. So, it's back to the original problem that we try to avoid. So, there is a need for some system in place there, just like how we expect sort of producers to have extended responsibility when they make a product, as users then needs to do the same thing as well."

P11GA: "We go around replacing laptops or desktops or printers or whatever, it gets placed on a specific tender, we have an auction site, I think in 'Suburb A'?"

P11GA: "So it would be the same as, let's say Clicks changing all their tills, and then what do they do with their old tills? Tills that are still functioning, obviously, or could be reconditioned, they'll take it to some place where it could be auctioned off. Now we have our own internal system, the same way as any other organisation."

P11GA: "...according to their tender, all our IT equipment needs to be auctioned, it needs to be condemned, once it's not in use anymore. Every couple of years each of us will be provided with a new laptop for instance, or a department will get a new printer, then you condemn the old one and it get put on that tender to be auctioned off"

P12GA: "In terms of our auction system, I think most of our equipment that we're auctioning is still sort off quite early on at the kind of picking order, so most of it is still working, it could still be refurbished or reused as working equipment."

P13GA: "But you see now here's a challenge, is that we have a system, and the system goes outside by getting a service provider to buy the material. We've got different service providers that's bid for that. Now when you compare that with what you are asking while you have to go out, is that there is already people out there, small men, that goes to companies that says; I need your laptops"

P19SCM: "You know, really where you've got traders pitching up there, bidding for the equipment, clearly knowing the economics of the equipment they're bidding on, and ultimately, you know, it all ends up in cherry picking, and they dump the no value, or low value material side of it, just to get to the cherries"

-Auction houses would be problematic

P1ES: "No, you're adding a third tier I don't think it will work. Effectively what's going to happen is that ... how would that auction house be structured, and who would be responsible for the management in control of that? Because if they are looking at the value and the waste and then selling it off, they would be better off adding value to that waste internally. It would be very difficult to manage the structure, unless it's a government type of facility, and there again it will come with internal problems as well."

P2ES: "So the negatives are, you're creating a central point, it means you're going to add another leg in the reversed logistics, because people have to transfer the waste there, they have to be then sorted again, and from the recyclers it has to go back to the recycler, so I think that potentially will be a problem, just from pure cost point of perspective. Secondly, it opens itself to monopolies, and I don't believe in monopolies. I think monopolies are unhealthy. Thirdly I think you might find some interest by the competition's commission, running a scheme like that. I think what's more beneficial and more practical is if you take the concept, and you don't centralise it, but you have a number of ... based once again on the GDP of each of the provinces, you have most material recovering facilities in each of the regions, because for us to deal, and I'm just going to a slightly higher level now, if you want to deal with a level of unemployment and a lower level of education, you have to be inclusive and you have to include the rural community"

P7GA: "...if you get rid of stuff through a public auction, by a municipality, be it small goods or large goods, you don't have any control thereafter, so if once the purchaser gets it from the auction, and it's deemed unfit for use, or irreparable and stuff, it still then ends up back at the landfill. So, it's back to the original problem that we try to avoid. So, there is a need for some system in place there, just like how we expect sort of producers to have extended responsibility when they make a product, as users then needs to do the same thing as well."

P15RDE: "To do that you need expertise....and that's generally the hurdle...and if you don't have expertise, it won't happen...and they'll just scrap it"

P15RDE: "But your problem is the volume. Volumes are small, and it's distributed all over the country."

P19SCM: "Hmmm, well, I don't know, I don't know [Referring to auction houses]. I think for a start you have two... you know there could be some conflict of interest, it all depends on how many of these setups, you know, if it's done in an open and a fair and a transparent and competitive manner, it all depends. You need a lot of control around this."

P19SCM: “Ja, it could be a concept that could be looked at, but from an extended producer responsibility point of view, ja, you would create a trading platform, and currently, I mean, if you look at this type of trading platforms being applied by the public sector, it fails dismally.”

P19SCM: “It could, it could, but I think it’s problematic in a developing economy, especially where industry is not well developed, where the industry, or where the material market, you know, is not well. It’s just open for abuse.”

P19SCM: “You know, your different stakeholders, your industry, guys in there need to be registered, they need to be checked, they need to apply standards. Ja, it could be a component, or let’s say it could be a substantial component of the ecosystem, but you know, you need all of ... you need a number of controls around the bigger environment.”

-In favour of auction houses for e-waste

P3ES: “I think it’s an excellent idea, because my personal experience shows me that government can be the biggest culprit, first of all, trying to source service providers where they can actually make a buck out of e-waste. They actually have been shopping around. I have been even phoned...(section removed to ensure anonymity) by the Department of XYZ, trying to find out if I can recommend who would pay them the best buck for e-waste, and it’s clearly not what we want to see.”

P3ES: “So I think an auction house set who’d be tightly controlled, would be an excellent idea.”

P4ES: “So I think it’s interesting [The idea of an auction house], because ... So firstly, okay, if you look at it from assistance perspective, what that means is, there’s another step in the chain, right, so it means there’s more logistics and what not, but if it works correctly and it’s done efficiently, then it can actually reduce downstream inefficiencies, “

P4ES: “but in terms of bidding [at an auction house], ja that’s quite interesting, and I don’t know ... I think it’s interesting because you could possibly get more value out of something, let’s say you’re getting x price for a ton of mixed electronic waste, or let’s see what it’s called ... that’s small appliances and what not, but ja, that’s probably not such a bad idea if you have the right people separating and maybe getting out the bad stuff as well, if it’s done correctly”

P4ES: “The only thing though is, and I can see this happening as this would require a waste license, and probably be a full EIA if it’s large and if it’s large volumes, which can potentially be a lot of money. Fact remain the government can step in and provide ... just with the waste servants in the Western Cape, where government provides infrastructure, but private sector runs it. The same thing can be done with this where you have ... They will like build a warehouse [for the auction house], or something like that, and the PRO’s will manage each of these different facilities, and then the money from that can either go to keeping the system operating.”

P8GA: "...but in terms of the auction house, you know, it can be good, it can be positive, but there can also be negatives. So, if, you know, we would have loved that registered recyclers will be allowed to auction, however, it's a free country, so each and every one can go and register an auction, but I don't follow, you know, the proper disassembling methods that you would maybe have in terms of an organised setup. If I actually buy stuff at the auction I can go home, I can disassemble it at home and you know, cause a lot of pollution. So, if we actually have a system in place, it needs to be then go to register people, and only it can then be distributed to that people, and not as an individual that come in and buy and I actually go back door and actually disassemble it and actually, you know ..."

P10GA: "I think that's a good idea. It's a good idea that nobody thought of it, because as you are saying, they don't take everything, and some they specialise, some they are ... you know they are taking only TV's because they know what they do the TV, this one will take only the washing machine, because they know what they do with the parts that they get from that washing machine."

P10GA: "Very brilliant idea. If we can have something like that, everything goes there, all the recyclers they just come and bid for the material that they want."

P14RDE: "A system like that will be very nice. You have to ask yourself though, who's going to be maintaining that."

P14RDE: "Yes. It sound like a very sound idea, a very good idea. Once again, the way that the markets are running in South Africa at the moment, it will be an amazing experience. I think it will be phenomenal, because you will put people in contact with one another, but once again, you will be stopping unwanted electronic waste ending up on the land fill, so an idea like that would be very nice, and it would be a very, very good initiative to start up, or to have implemented through the whole of South Africa,"

P14RDE: "...it should be a phenomenal achievement for South Africans. Once again, know we're stimulating, as I said, the GDP, the gross domestic product in South Africa, and that's the biggest thing at the moment as well."

P16RDE: "I definitely think that one could work, but I think ... ja, there's a bit of semantics and evolved comment in depth on that"

P16RDE: "It definitely could work, ja, it's interesting, it could work definitely. Obviously our government wants to align with what they're trying to do in their national government plans with what they're creating. With creating an auction house it's a free market, which is great, and you'll get the most value, which means then the bottom guy who is the tier four guy picker / sorter, he's going to get the most bank for his buck with that model, which is great, but then how does government try to achieve their ... of making jobs within that industry when they're summoned to come to the auction centre and ... ja, do it maybe a rudimentary way or a non-complaint way."

P18RDE: "Ja, it will definitely work [Referring to auction houses], and there will be interest, but again, it's just on what's the need for the different types. Like I know PC's, everybody wants it, especially because of the components inside and the boxes, it's all recyclable."

ANNEXURE B

Figure B1: WEEE Collection methods in South Africa

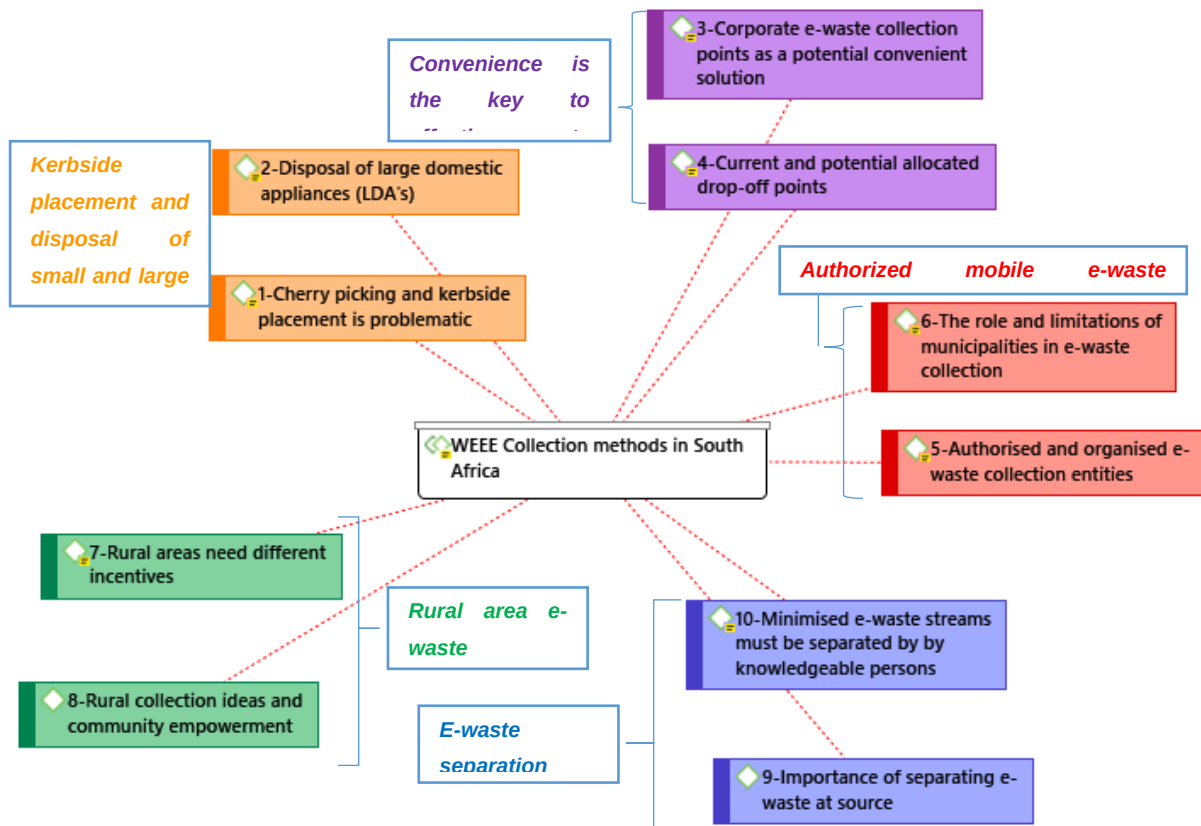


Figure B2: Transport problems and responsibilities

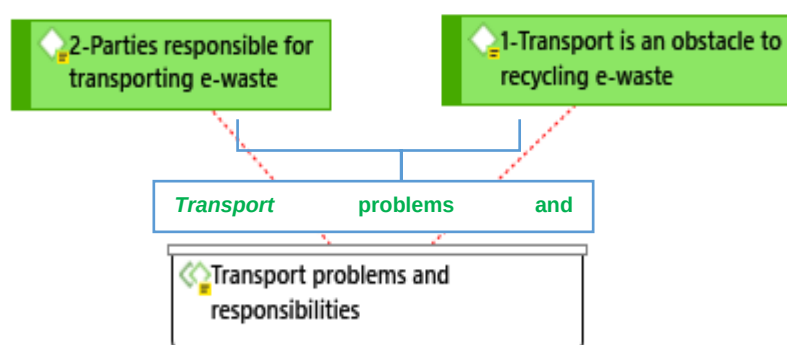


Figure B3: Extended Producer Responsibility (EPR)

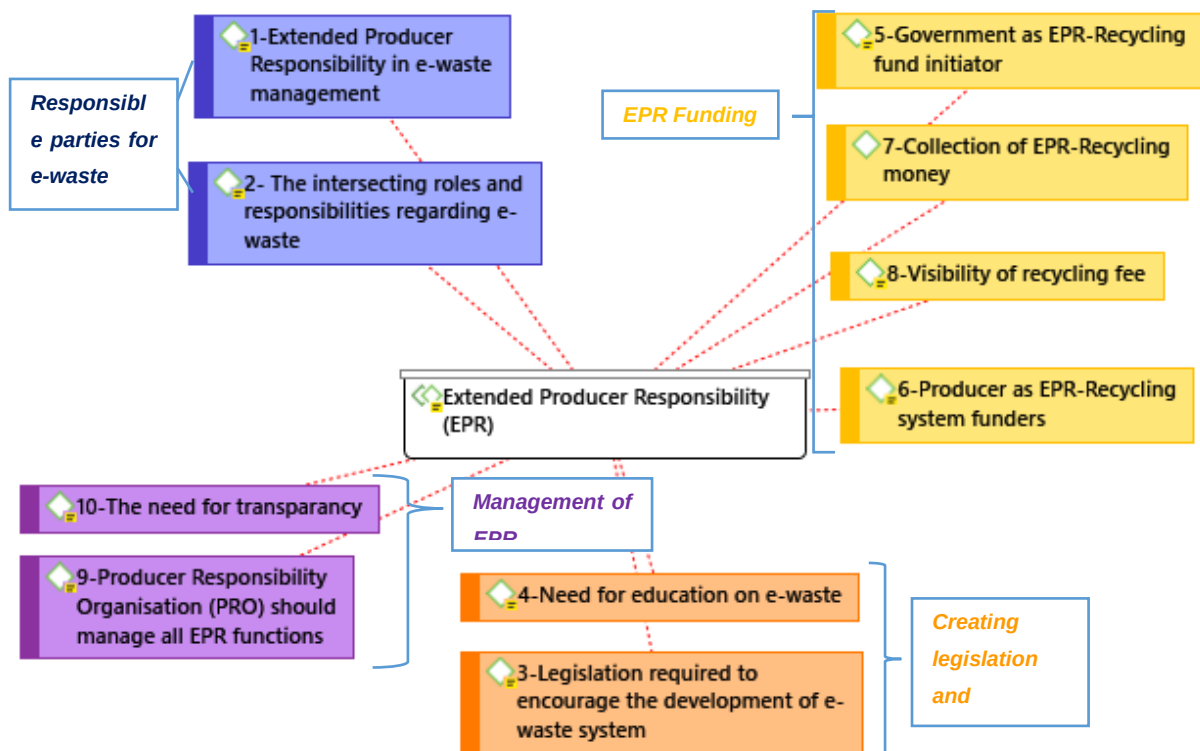


Figure B4: Problem areas regarding recycling infrastructure in South Africa and the role of Government to address the recycling needs

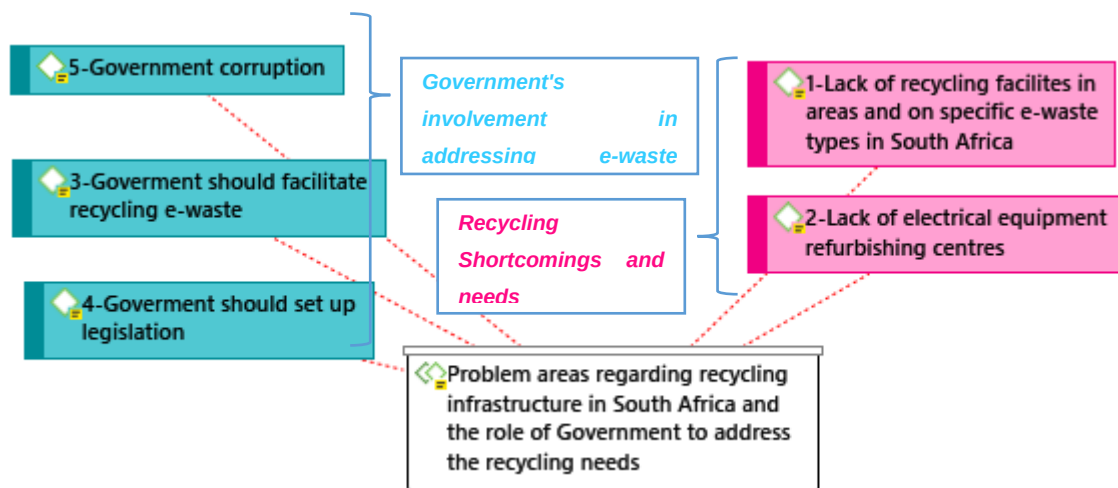


Figure B5: Producer Responsibility Organisation (PRO)

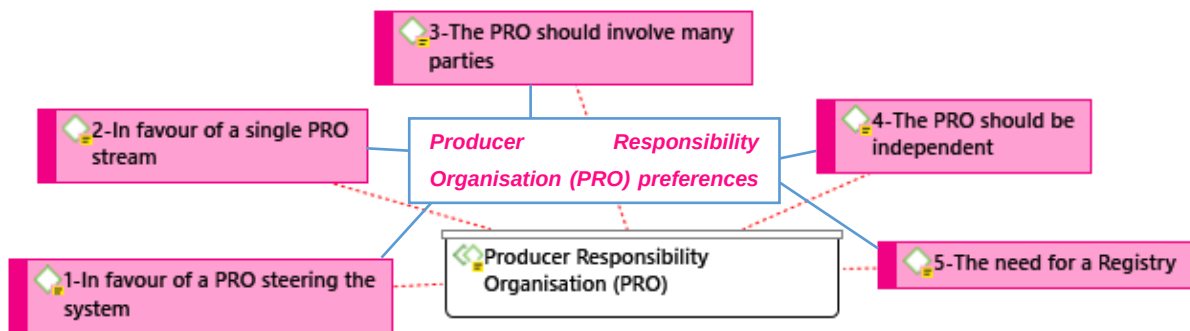


Figure B6: Take Back scheme and rewards system

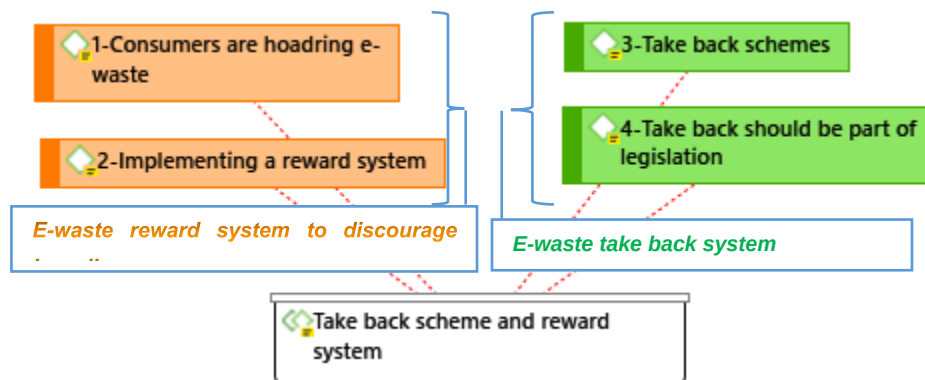
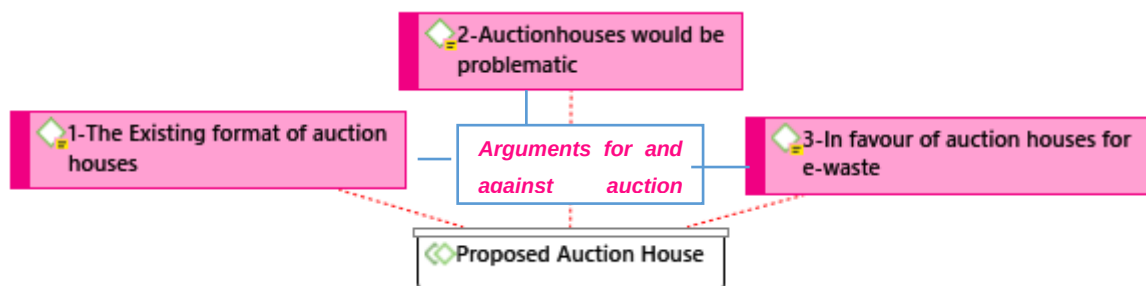


Figure B7: Proposed auction house



ANNEXURE C

Table C:1 Comments received from groupings

Category				Code		Ideas		Env Specialists				Government agencies														Recycle-Disposal Entity					Sup- ply			
												P 1	P 2	P 3	P 4		P 5	P 6	P 7	P 8	P 9	P 10	P 11			P 12	P 13		P 14	P 15	P 16	P 17	P 18	
5.5.1- Kerbside placement and disposal of small and large e- waste appliances				- Cherry picking and kerbside placement is problematic		Health + Env concerns	x	x	x			x					x	x					x	x					x					
						informal sector untrained			x							x														x			x	
						Make informa illegal	x			x								x													x			
						Train informal											x																	
				- Disposal of large domestic appliances (LDA's)		LDA's size problem			x	x			x	x				x						x	x								x	
						Uber system-Call -to-collect	x			x	x			x	x									x								x	x	
5.5.2- Convenienc e is the key to effective e-waste collection				- Corporate e- waste collection points as a potential convenient solution		Positive towards receptacle at work	x								x	x										x			x					
						Warn Against receptacle at work																x												
				- Current and potential		Calling for Safe,			x	x										x										x	x			

			allocated drop-off points		convenient, secure																									
					Shopping mall, retail point, parking area		x	x	x							x	x					x	x	x			x		x	x
					Against retailer collect																									x
					Garden refuse site	x		x									x	x		x				x						
5.5.3- Authorised mobile e-waste collection			- Authorised and organised e-waste collection entities	Mobile unit collecting on specific day	x	x	x			x					x													x		
				- The role and limitations of municipalities in e-waste collection	Municipal collection would be ideal									x	x							x								
			Lack of motivation																		x									
			e-waste not secure																									x		
			Vehicles not suitable			x		x							x	x	x	x	x		x				x			x		
5.5.4-Rural area e-waste collection			- Rural areas need different incentives	Rewards needed for rural	x	x	x							x	x										x		x	x		
			- Rural collection ideas and	Can generate	x	x									x					x										

				community empowerment	income and create jobs																						
					Drop off collecting all types of recyclable material	x	x				x						x					x			x		
5.5.5-E-waste separation stages		- Importance of separating e-waste at source	Keep e-waste separate from other waste	x	x	x	x		x					x						x		x				x	
			Further separation at collection points-knowledgeable persons				x		x					x													x
		- Minimised e-waste streams must be separated by knowledgeable persons	Minimum streams must be in place				x																				
			knowledgeable person separate			x	x		x					x			x				x	x					x
5.6.1-Transport problems and		- Transport is an obstacle to recycling e-waste	Transport is over regulated			x																					
			Transport must be co-ordinated	x	x	x								x	x						x	x				x	x

responsibilities				due to high costs																								
			- Parties responsible for transporting e-waste		Recycler must pay				x						x	x					x	x			x		x	
					Producers must pay						x																	
					Auction house must pay			x	x							x						x	x	x				
5.7.1- Responsible parties for e-waste management			- Extended Producer Responsibility in e-waste management	Real need for EPR	x			x		x				x							x					x		
				Producers should run it		x		x						x	x	x	x					x					x	
			- The intersecting roles and responsibilities regarding e-waste	Prod are responsible	x	x		x							x					x								
				Retailers must take back and educate		x	x								x					x		x					x	x
				Consumers must dispose correctly		x		x							x		x	x										x
				Gov. must set up/start system									x								x							
5.7.2- Creating legislation and			-Legislation required to encourage the development	Legislation needed to involve all stakeholders	x	x	x			x				x		x				x	x	x				x		

[illegible]

5.7.4- Managemen t of EPR	- Producer Responsibilit y Organisation (PRO) should manage all EPR functions	Must be run by producers	x		x			x				x			x						x		x	
		No Gov involve- ment, only report to gov	x			x		x				x			x						x		x	
	- The need for transparency	Fraud and admin hassles must be minimum	x	x	x	x									x								x	
		Public involved trough civil rights groups	x		x			x																
5.8.1- Recycling Shortcomin gs and needs	- Lack of recycling facilities in areas and on specific e- waste types in South Africa	No rec facilities for some categories	x	x	x	x						x			x			x					x	x
		Rural and country, has no rec facilities	x			x						x			x			x		x			x	
	- Lack of electrical equipment refurbishing centres	Refurbis- hing needed	x			x		x		x								x					x	x

5.8.2- Government 's involvement in addressing e-waste recycling needs	-Government should facilitate recycling e- waste	Industry must write norms and standards	x					x							x								x	
		Gov should ensure implement- ation	x	x	x	x		x					x		x								x	
	-Government should set up legislation	Achievable, auditable checks and balances	x		x	x		x										x	x		x	x	x	
	-Government corruption	If SARS takes money it will be lost	x		x	x		x		x							x							
5.9.1- Producer Responsibili ty Organisatio n preferences and functions	-In favour of a PRO steering the system	PRO should steer process	x	x	x	x		x				x			x			x		x		x	x	
		Only legit recyclers involved						x									x					x		
	-In favour of single PRO stream	Single PRO needed	x	x	x	x		x		x		x	x			x								
		Single PRO- different streams	x		x	x		x		x		x												
	-The PRO should involve many parties	NGO with representa- tive board	x		x							x	x											
		Watchdogs -OUTA	x		x																			

			-The PRO should be independent	No Gov interfe- rence	X	X																		X	
			-The need for a Registry	To ensure all is involved	X	X	X					X													
5.10.1-E-waste reward system to discourage hoarding			-Consumers are hoarding e-waste	Sentimental attachment to items	X		X	X												X				X	X
			- Implementing a reward system	Reward is needed to get process going	X	X	X	X		X		X	X	X	X				X	X	X	X	X	X	X
				Concern about sustainability	X					X		X		X											
				Cashless system			X	X	X		X			X		X		X	X			X			X
5.10.2-E-waste take back system			-Take back schemes	Retailers should take back e-waste			X	X	X		X			X		X		X		X		X			
				Retailers not trained -space										X								X			X
			-Take back should be part of legislation	Keep record				X														X			
5.11.1-Arguments for and			-The Existing format of	No strict rules preventing				X				X				X	X	X						X	

against auction houses	auction systems	fly by nights																							
	-Auction houses would be problematic	Foresee possible problems	x	x													x							x	
	-In favour of auction houses for e- waste	Can work			x	x					x		x				x		x		x				

ANNEXURE D

Participants to the study

Important points

- Permission is requested to record the conversation.
- Informed consent will be completed before interview.
- Interviews will be around 1 hour.
- Anonymity (your suggestions and preferences will not identify you) and Confidentiality (your identity) is guaranteed.
- **Ethics Number:** NWU-00040-16-S1.

Purpose of the study

The purpose is to determine your role, experiences, preferences, views and understanding of what is needed in the e-waste sector to ensure that household consumer e-waste is managed effectively in the future.

INTERVIEW QUESTIONS:

TOPIC 1: COLLECTION OF E-WASTE FROM HOUSEHOLD CONSUMERS	
	<i>Intro: I would like your view on e-waste collection of e-waste from household consumers</i>
4.	In your opinion, what should the responsibility be of household consumers of electrical equipment when the items become e-waste and have to be discarded?
5.	Which collection methods or places will be suitable and safe for the South African environment to collect large and small household e-waste? (Please discuss this in terms of urban and rural environments)
6.	What is your view on a reward system to encourage consumers to return household e-waste items, and if you support it, what should the reward system look like and how should it be implemented?
TOPIC 2: E-WASTE DISTRIBUTION TO RECYCLERS	
	<i>Intro: Collection points are used for different types of household e-waste. SA recyclers also focus on different types of e-waste. I would like your view on e-waste distribution to recyclers.</i>
4.	Who will have to ensure that the different e-waste streams are separated and how/where should the e-waste separation be conducted?
5.	Irrespective of where the separation of the different e-waste streams is done, who should be responsible for the transport of the e-waste to the recyclers?
6.	To your knowledge, in which areas is there still a lack of e-waste recycling facilities, and what can be done to address the shortcomings?
TOPIC 3: MECHANISMS TO REGULATE AND PROMOTE A SUSTAINABLE E-WASTE MANAGEMENT SYSTEM IN SOUTH AFRICA.	
	<i>Intro: The government indicated that an EPR system should be the way forward, which implies a mandatory system. I would like your view on mechanisms to regulate and promote a sustainable e-waste management system in South Africa.</i>
6.	Do you foresee a Take-Back programme (for same category items), how should it be implemented, and who should manage it?
7.	How should the management of an EPR system for e-waste be funded and who should manage the funds?
8.	As part of an EPR programme, the norm is to have PRO's. What is your view on PRO's (is it necessary?) and PRO grouping for the South African scenario?

9.	In terms of the management of the system, who should be in charge of the different aspects of the e-waste system? Probe for the following: - <i>the storage, collection and transport logistics,</i> - <i>communication between stakeholders,</i> - <i>the financial management</i> - <i>treatment/accreditation</i> - <i>setting of Performance standards,</i> - <i>setup and management of a registry to capture/register all stakeholders.</i>
10.	What is your opinion on the role of Government in order to ensure an e-waste management system?

ANNEXURE E

Interviewer Guide with probing questions

Research objectives	Topics in interview guide
Research objective 1: To understand the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on the collection of e-waste from household consumers.	Topic 1: Collection of e-waste from household consumers.
Research objective 2: To understand the current practices and views key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on e-waste distribution to recyclers once it has been collected.	Topic 2: E-waste distribution to recyclers.
Research objective 3: To explore the view of key stakeholders on alternative mechanisms to develop a sustainable e-waste management systems in South Africa.	Topic 3: Mechanisms to regulate and promote a sustainable e-waste management system in South Africa.
Research objective 4: Develop a framework for the effective management of e-waste in South Africa.	Will be done based on findings and literature review

THE INTERVIEW GUIDE FOR IN-DEPTH INTERVIEWS WITH PRACTITIONERS

- Request permission to record the conversation
- Informed consent will be confirmed

OPENING QUESTIONS

Greetings and informal conversation.

BACKGROUND AND PURPOSE OF THE STUDY.

The purpose is to determine your role and understanding of what is needed in the e-waste sector to ensure that household consumer e-waste is managed effectively in the future.

INTERVIEW QUESTIONS: Contextualisation and experience

1.	Could you please describe to me your company/organisation? (Probe for the focus and interest in the EEE/WEEE sector, experience, impact in sector)
2.	What is your position and role in this environment?
3.	What is the size of the organisation that you function in?

Topic 1- Collection of e-waste from household consumers.

7. In your opinion, what should the responsibility be of household consumers of electrical equipment when the items become e-waste and has to be discarded?

(Probe for

-dumping at refuse sites?

-dumping in refuse bags?

-placing on curb side?

-Transport - What if no transport is available?

-Safety (e.g. CFL's that can brake).

Listen for other considerations)

8. Which collection methods or places will be suitable and safe for the South African environment to collect Large and Small household e-waste? (Please discuss this in terms of urban and rural environments.)

(Probe for

- Methods:

- 'Take back' at retailers,

- Curb side placement (cherry picking?)

- House collection,

- Municipal trucks –capabilities and space

- Own delivery to site

- Central collection arrangement of large e-waste

- Dedicated collection days at malls or other places?(Urban/Rural?)

- Places:

- Large shopping centres-how?

- Retailers,

- Apartments?

- Work places-e.g. larger than 100 employees?

- Municipal sites and garden refuse? Space availability, etc.

Listen for other considerations)

9. What is your view on a reward system to encourage consumers to return household e-waste items, and if you support it, what should the reward system look like and how should it be implemented?

(Probe for System rewards

-e.g. cash?

-airtime, loyalty awards-Absa rewards, E-bucks etc.

-Capabilities and means of personnel to capture consumer data at proposed collection points.

-Management of system (who?),

Listen for other considerations)

Topic 2: <u>E-waste distribution to recyclers.</u>
<u>Statement:</u> Collection points will have different types of household e-waste and SA recyclers also focus on different types of e-waste.
7. Who will have to ensure that the different e-waste streams are separated and how/where should the e-waste separation be conducted? (Probe for -organised transport from collection points to central points (close to recyclers), -separation into different streams, -the idea of tendering or use of an <u>e-waste auction house</u>, from where it can be released to recyclers, -Central control? - Listen for other considerations).
8. Irrespective of where the separation of the different e-waste streams is done, who should be responsible for the transport of the e-waste to the recyclers? (Probe for -Responsibility of co-ordination of collection/transport -Financial responsibility for transport, etc. Listen for other considerations).
9. In which areas are there still a lack of e-waste recycling facilities and what can be done to address the shortcomings? (Probe for -Placement of facilities-where, -Responsibility for implementation, -Finances etc. Listen for other considerations).
Topic 3: <u>Mechanisms to regulate and promote a sustainable e-waste management system in South Africa.</u>
<u>Statement:</u> Government already indicated that an EPR system should be the way forward which implies a mandatory system. Based on this: (If you disagree with an EPR system please discuss with interviewer)
11. Do you foresee a Take-Back program (for same category items) and how should it be implemented and who should manage it? (Probe for -retailer, -shopping mall and -internet sales participation. (Listen for other considerations).
12. How should the management of an EPR system for e-waste be funded and who should <u>manage</u> the funds? (Probe for -Recycling fee, -How should it be collected ? -what the funds will be used for. -Management of funds ? Listen for other considerations).
13. As part of an EPR program the norm is to have PRO's. What is your view on PRO's (is it necessary) and PRO <u>grouping</u> for the South African scenario? (Probe -which e-waste categories must be grouped together,

- 1-Problem items, 2-low electronics high materials, 3- high electronics, low material ?

-stakeholder involvements in PRO's-what should it look like?

Listen for other considerations).

14. In terms of the management of the system, who should be in charge of the different aspects of the e-waste system?

- *the storage, collection and transport logistics,*
- *communication between all stakeholders,*
- *the financial management*
- *treatment/accreditation*
- *setting of Performance standards,*
- *setup and management of a registry to capture/register all stakeholders.*

(Probe for

- Single entity or more, Producers, Government, Recyclers, E-WASA or eWA?

Aspects such as:

- *the storage, collection and transport logistics,*
- *communication between stakeholders,*
- *the financial management*
- *treatment/accreditation*
- *setting of Performance standards,*
- *setup and management of a registry to capture/register all stakeholders.*

Listen for other considerations)

15. What is your opinion on the role of Government in order to ensure an e-waste management system?

(Probe for

- involvement in setting up of dedicated legislation,

- initiating platforms to get all stakeholder involvement, etc.

Listen for other considerations)

ANNEXURE F

QUESTIONNAIRE ON THE BEHAVIOURS OF CONSUMERS OF HOUSEHOLD E-WASTE.

Definition of E-waste - Electrical or Electronic equipment become waste (called **e-waste**) when it reaches a point where it has to be discarded due to failures or being outdated. All items that operate using batteries or electricity are included. A few examples of e-waste in households are fridges, freezers, stoves, kettles, irons, televisions, computers, printers, batteries, electric toys, cellular phones, electric drills, lawnmowers, lights, solar cells, etc. All the parts of the electrical or electronic equipment then become part of the **e-waste** stream.

Recycling of e-waste – This refers to the processes to extract reusable and recyclable material from the e-waste stream.

A.	ENVIRONMENTAL AWARENESS:					
10	<u>Please indicate to what extent you agree or disagree on the statements with regards to environmental awareness.</u>					
1	<i>I am often concerned about environmental issues</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
2	<i>I think that our daily habits can affect the environment.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
3	<i>I think everyone should contribute to protect the environment.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
B.	ATTITUDE TOWARDS E-WASTE RECYCLING.					
11	<u>Please indicate to what extent you agree or disagree on the statements with regards to your attitude towards e-waste recycling.</u>					
4	<i>I believe that recycling of e-waste can reduce environmental pollution.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
5	<i>I believe that informal recycling of e-waste can pollute the environment.</i> (Informal recycling of e-waste refers to the extraction of material from the e-waste stream by people that are not part of any official structures. Examples are waste pickers.)	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
6	<i>I believe that recycling of e-waste can protect the use of natural resources.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
7	<i>I would like to contribute to the reduction of harmful e-waste.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
8	<i>I believe that all households should voluntarily participate in e-waste recycling.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
9	<i>I support initiatives that aim to set up an organised e-waste collection system.</i> (An organised e-waste collection system refers to the actions of consumers or stakeholders to actively participate in the handing over or dropping off of e-waste where it is received and stored for further processing.)	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
10	<i>I support initiatives that aim to set up an organised e-waste recycling system.</i> (An organised e-waste recycling system refers to the integration of efforts, programs and processes to extract reusable and recyclable material from the e-waste stream.)	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5

C.	<u>NORMS AND PUBLICITY:</u>					
12	<u>Please indicate to what extent you agree or disagree on the statements with regards to norms and publicity.</u>					
11	<i>There are sufficient laws and regulations governing e-waste recycling in South Africa.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
12	<i>The media publish enough information on formal e-waste recycling. (Formal e-waste recycling implies that the collection of e-waste happens under controlled conditions, the recycling infrastructure of e-waste is in place, and e-waste legislation is in place.)</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
13	<i>The media publish relevant information on formal e-waste recycling.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
14	<i>The people around me participate in formal e-waste recycling.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
D.	<u>COSTS OF RECYCLING:</u>					
13	<u>Please indicate to what extent you agree or disagree on the statements with regards to the cost of recycling.</u>					
15	<i>Traveling costs to dispose e-waste is high.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
16	<i>The time spent by me to dispose e-waste is high.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
17	<i>The compensation for returning e-waste is too small to be worthwhile.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
18	<i>The handling charges for e-waste recycling will be high.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
E.	<u>CONVENIENCE OF RECYCLING:</u>					
14	<u>Please indicate to what extent you agree or disagree on the statements with regards to the convenience of recycling.</u>					
19	<i>I have time to deliver e-waste to a collection point.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
20	<i>I have transport to take large e-waste (fridge, stove, etc.) to a collection point.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
21	<i>I can take small e-waste (kettle, toaster, radio, etc.) to a collection point.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
22	<i>I think recycling channels in my neighbourhood are adequate.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
23	<i>I think recycling channels in my neighbourhood are close enough to my residence.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
F.	<u>BEHAVIOURAL INTENTION:</u>					
15	<u>Please indicate to what extent you agree or disagree on the statements with regards to behavioural intention.</u>					
24	<i>I'm willing to spend time to take my old electronic appliances to collection points.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
25	<i>I am willing to speak to my friends about appropriate methods for disposal of e-waste.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
26	<i>I am willing to get more information about appropriate methods to dispose e-waste.</i>	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5

G.	AWARENESS AND ATTITUDE TOWARDS A POINTS REWARDS SYSTEM (PRS). <i>(A PRS is a system where people receive some form of points in return for spending money at a place. The points can then be substituted for airtime, food, data, fuel, etc.)</i>					
27	Are you aware of current Points Rewards Systems? Examples are E-Bucks, U-count awards, Pick n Pay rewards, ABSA rewards, etc.?	Yes 1	No 2			
28	Are you currently participating in any form of Points Rewards Systems?	Yes 1	No 2			
H.	WILLINGNESS TO PARTICIPATE IN E-WASTE RECYCLING WITH POINTS REWARDS SYSTEM: <i>(E-waste Points Rewards System (PRS) - An e-waste PRS is a system where people receive some form of points when they return e-waste.)</i>					
16	<u>Please indicate to what extent you agree or disagree on the statements with regards to willingness to participate in e-waste recycling with a PRS.</u>					
29	I would be willing to participate in an organised e-waste recycling system which uses a PRS.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
30	An organised e-waste recycling system which uses a PRS would make me aware of my own carbon footprint.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
31	The number of points awarded when I return e-waste would be important to me.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
32	The type of products/services awarded when I return e-waste would be important to me.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
I.	ACCOUNTABILITY TO RECYCLE E-WASTE.					
17 33	<u>Please indicate to which extent do you agree or disagree on the statements with regards to accountability to recycle e-waste</u>					
33.1	I believe that the government should be responsible to recycle e-waste.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
33.2	I believe that the manufacturer/importer of the electrical or electronic product should be responsible to recycle e-waste	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
18 33 .3.	I believe that the seller/retailer of the electrical or electronic product should be responsible to recycle e-waste.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
19 33 .4	I believe that the consumer of the electrical or electronic product should be responsible to recycle e-waste.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
20 33 .5	I believe that the municipalities should be responsible to recycle e-waste.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
<u>Please indicate to which extent do you agree or disagree on the statements with regards to payment of a recycling fee.</u>						
34.	I believe that the payment of a recycling fee should be part of the product price when the product is purchased.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
35.	I believe that the payment of a recycling fee should be collected when the product is disposed.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
36.	I am willing to pay for a part of the costs to recycle my e-waste.	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
37.	If consumers <u>have</u> to pay part of the recycling costs for e-waste, what percentage of the selling price will be acceptable to you? Mark ONE					
21	0 to 6%					
22	7 to 12%					
23	13 to 18%					
24	19 to 25%					
25	more than 25%					

J.	CURRENT BEHAVIOUR.	
38	<i>How do you typically deal with your households' e-waste? (Mark ALL applicable options)</i>	
26 .1	Dispose with ordinary garbage.	
27 .2	Dispose along with separated waste (If you separate your organics and recyclables)	
28 .3	Dispose of it at a collection point specific for electronic-waste	
29 .4	Take it to a specific collection point as indicated by the manufacturer	
30 .5	Return to the store where I purchased it	
31 .6	Donated it to a charity institution	
32 .7	Give it to other people who could use it or repair it for themselves.	
33 .8	Store it at my residence.	
34 .9	Other	
35	If other please describe	

K.	BIOGRAPHICAL DATA

39. Please indicate your gender.

Male	1	Female	2

40. Please indicate your current age.

18-24 years	25-34 years	35 – 44 years	45-49 years	More than 50 years
1	2	3	4	5

41. Please indicate your city of residence.

City of Cape Town	1
EThekweni - Durban	2
City of Johannesburg	3
Ekurhuleni-Germiston, Benoni, Kempton park, etc	4
Tshwane - Pretoria	5

42. Please indicate your personal monthly income before deductions.

Less than R6401	1	R51201 – R64000	6
R6401 - R12800	2	R64001 – R76800	7
R12801 - R25600	3	R76801 or more	8
R25601 – R38400	4		
R38401 – R51200	5		

43. Please indicate your Education level

Education Level	Mark highest education level
Grade 1 to 11	
Grade 12	
Diploma/Degree/BTech	
Honours level Degree	
Masters/PhD Degree	
Other	

44. Please indicate your home language

Home language	Mark language
English	
Afrikaans	
IsiNdebele (Ndebele)	
IsiXhosa (Xhosa)	
IsiZulu (Zulu)	

Sepedi (Northern Sotho)	
Sesotho (Southern Sotho)	
Setswana (Tswana)	
SiSwati (Swati)	
Tshivenda (Venda)	
Xitsonga (Tsonga)	
Other – (Please specify)	



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10 July 2017

To whom it may concern

RE: Request for assistance/participation.

This letter confirms that Mr. AJJ Mouton is a registered PhD student (PhD Engineering-Development and Management) at North West University, Potchefstroom campus. He is doing his research on an effective management model for Waste Electrical and Electronic Equipment (e-waste) for South Africa. To make a significant contribution in the research area inputs from stakeholders in the e-waste field is of utmost importance. Stakeholders that have been identified are the Supply Chain (importers of electrical/electronic equipment, SA assemblers/manufacturers, Traders, Distributors, and Retailers), Government authorities (Municipalities, local authorities, Central Government, DEA, and Provincial Government), Disposal and Recycling companies (Collectors, recyclers, and Disposal sites), Consumer representatives (Environmentalists, Civic organizations, e-waste associations) and consumers. If you are identified as a stakeholder, and the student (Mr. Mouton) has selected you to participate in the study, your assistance/participation will be highly appreciated. In line with government regulations, to protect universities and participants, ethical clearance has been obtained. Anonymity and confidentiality are guaranteed.

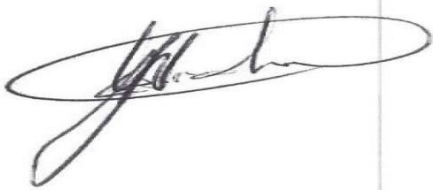
Title: A framework for the re-use, recycling and disposal of waste electrical and electronic equipment. The South African case.

Ethics Number: NWU-00040-16-S1

Name of Student: (Principle researcher): Mr. AJJ Mouton
Student nr: 23948272
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Project head (Study leader): Prof JH Wichers
Department: School of Mechanical and Nuclear Engineering
e-mail: harry.wichers@nwu.ac.za
Tel –Work: 0182994283

With regards

A handwritten signature in black ink, appearing to be 'JH Wichers', enclosed within a large, loopy oval stroke. A vertical line is drawn to the right of the signature.

Prof JH (Harry) Wichers

PhD; Pr Ing; GCC

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EngREC Stamp

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR STAKEHOLDERS IN THE e-WASTE ENVIRONMENT.

TITLE OF THE RESEARCH PROJECT: A FRAMEWORK FOR THE RE-USE, RECYCLING AND DISPOSAL OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT. THE SOUTH AFRICAN CASE.

REFERENCE NUMBERS: NWU-HS-2017-0063

PRINCIPAL INVESTIGATOR: Prof H Wichers

PRIMARY INVESTIGATOR: Mr. AJJ MOUTON

ADDRESS: WALTER AVE 1458, WAVERLEY, PRETORIA, 0186 CONTACT

NUMBER: 083 415 5130

You are being invited to take part in a research project that forms part of my PhD research. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Engineering Research Ethics Committee of the Faculty of Engineering of the North-West University (NWU-HS-2017-0063)** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics

Council. It might be necessary for the research ethics committee members or relevant authorities to inspect the research records.

What is this research study all about?

- *The objectives of this research are: 1) To understand the current practices and views of key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on the collection of e-waste from household consumers, 2) To understand the current practices and views key stakeholders involved in the life cycle of electrical and electronic equipment with the focus on e-waste distribution to recyclers once it has been collected, 3) To explore the view of key stakeholders on alternative mechanisms to develop a sustainable e-waste management system in South Africa. With your inputs a proposed framework for South Africa to effectively refurbish and recycle e-waste will be developed.*

Why have you been invited to participate?

- *You have been invited to participate because you are either a South African consumer of Electrical and Electronic equipment which will eventually become e-waste, or you are a stakeholder in the e-waste environment who can make a significant contribution to the development of a proposed e-waste management framework.*
- *You have also complied with the following inclusion criteria: you are not in a work related subordinate position with me as the researcher conducting the research; willing to participate in the research through informed consent; willing to complete the questionnaire; and able to communicate freely and express yourself adequately.*
- *After completion of the questionnaire or interview you will be excluded if you indicate that you do not want to be part of the study any longer.*

What will your responsibilities be?

- *You will be expected to either 1) complete the single questionnaire which will take between 20 and 30 minutes (Consumers) or 2) be interviewed by the primary researcher for duration of around 45 minutes to 1 hour.*

Will you benefit from taking part in this research?

- *The direct benefits for you as a participant will be that you will immediately become aware of the hazardous nature of WEEE and will get immediate guidance on what to do with small WEEE stored in your home.*
- *The indirect benefit to the research community and the country will be that a researched framework will exist which can guide all stakeholders in e-waste to ensure safe e-waste recycling and disposal as well as a cleaner and safer environment for South Africa.*

Are there risks involved in your taking part in this research?

- *The risks in this study are minimal due to the research being more of a fact and perception finding nature. The questionnaire completion (consumers) or interviews (other stakeholders) are totally anonymous and confidential. No undue influence can or will be exercised.*

- *The benefits outweigh the risk.*

What will happen in the unlikely event of some form of discomfort occurring as a direct result of your taking part in this research study?

- *Should you have the need to discuss or complain about any of the questions in the questionnaire or the interview questions you can e-mail me at moutonajj@tut.ac.za or my supervisor, Prof H Wichers at harry.wichers@nwu.ac.za. All questions or comments will be handled with discretion.*

Who will have access to the data?

- *Anonymity is guaranteed. Confidentiality will be ensured by the way data will be collected and captured. For completion of the questionnaire no information of the participants will be available. Only the primary researcher will have the details of the persons being interviewed. This will not be shared with anyone. Data analysis will possibly be done by an external company but a confidentiality agreement will be signed (no details of interviewees will be shared). Reporting of findings will be anonymous. Data will be stored for a duration determined by the North West University. .*

What will happen with the data/samples?

- *This is a once off collection and data will be kept safe and secure by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. The data will be analysed in South Africa.*

Will you be paid to take part in this study and are there any costs involved?

- *No, you will not be paid to take part in the study. This is a voluntarily questionnaire/interview and there will thus be no costs involved.*

Is there anything else that you should know or do?

- You can contact AJJ Mouton at 0834155130 or at moutonajj@tut.ac.za if you have any further queries or encounter any problems.
- You can contact the Engineering Research Ethics Committee via Mr Willem van Niekerk at 018 299 1317; willem.vanniekerk@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the primary researcher.
- You will receive a copy of this information and consent form for your own records.

How will you know about the findings?

- The findings of the research will be shared with you by the researcher should you wish to receive a copy of the final results. Please send an e-mail to moutonajj@tut.ac.za to request a copy.

Declaration by participant

By signing below, I agree to take part in a research study titled: **A framework for the re-use, recycling and disposal of waste electrical and electronic equipment. The South African case.**

I declare that:

- I have read this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher and all my questions have been adequately answered. (not included in questionnaire)
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to. (not included in questionnaire)

Signed at (*place*) on (*date*) 20....

.....
Signature of participant

.....
Signature of

witness Declaration by person obtaining consent

I (*name*) declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) on (*date*) 20....

.....
Signature of person obtaining consent

.....
Signature of witness

Declaration by researcher

I (*name*) Mr. AJJ Mouton declares that:

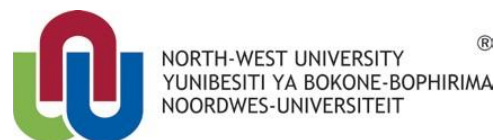
- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) on (*date*) 20....

.....
Signature of researcher

.....
Signature of witness

ANNEXURE I



Private Bag X6001, Potchefstroom,
South Africa, 2520

Tel: (018) 299-4900

Faks: (018) 299-4910

Web: <http://www.nwu.ac.za>

Institutional Research Ethics Regulatory Committee

Tel: +27 18 299 4849

Email: Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by the **Engineering Research Ethics Committee (EngREC)** on **27/03/2017**, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IRERC) hereby **approves** your study as indicated below. This implies that the NWU-IRERC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Project title: A framework for the re-use, recycling and disposal of waste electrical and electronic equipment: The South African case.																															
Project Leader/Supervisor: Prof. JH Wichers																															
Student: B Mouton																															
Ethics number:	<table border="1"><tr><td>N</td><td>W</td><td>U</td><td>-</td><td>HS</td><td>-</td><td>2</td><td>0</td><td>1</td><td>7</td><td>-</td><td>0</td><td>0</td><td>6</td><td>3</td></tr><tr><td colspan="4">Institution</td><td colspan="4">Year</td><td colspan="7">Project Number</td></tr></table>	N	W	U	-	HS	-	2	0	1	7	-	0	0	6	3	Institution				Year				Project Number						
N	W	U	-	HS	-	2	0	1	7	-	0	0	6	3																	
Institution				Year				Project Number																							
Application Type: Original Application																															
Commencement date: 2017-03-27	Expiry date: 2020-03-27																														
Risk:	Minimal																														

Special conditions of the approval (if applicable):

- Translation of the informed consent document to the languages applicable to the study participants should be submitted to the EngREC (if applicable).
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the EngREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-IRERC via EngREC:
 - annually (or as otherwise requested) on the progress of the study, and upon completion of the project
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
 - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the proposal as stipulated in the application form. Would any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these changes at the EngREC. Would there be deviated from the study proposal without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC via EngREC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-IRERC and EngREC retains the right to:
 - request access to any information or data at any time during the course or after completion of the study;
 - to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the EngREC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.
- EngREC can be contacted for further information or any report templates via Tania.Visser@nwu.ac.za or 018 285 2278.

The IRERC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the IRERC or EngREC for any further enquiries or requests for assistance.

Yours sincerely

Prof LA

Digitally signed by
Prof LA Du Plessis

Du Plessis

Date: 2017.04.10
12:22:42 +02'00'

Prof Linda du Plessis

Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)

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