Creating awareness of electronic waste and green information technology practices at higher education institutions through digital storytelling

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DECLARATION

I, Ramadile Moletsane, declare that:

Creating awareness of electronic waste and green information technology practices at higher education institutions through digital storytelling

is entirely original to me, and any references to any other sources have been made with full citations.

LIST OF ASSOCIATED PUBLICATIONS

Moletsane R.I., and Venter, C. (2018), The 21st Century Learning Environment Tools as Waste, Proceedings of the World Congress on Engineering and Computer Science 2018 Vol I WCECS, San Francisco, USA, 23-25 October, pp. 188-192, ISBN: 978-988-14048-1-7.

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Moletsane R.I., and Venter, C. (2018), Transboundary Movement of Electronic Waste, Issues and Challenges in African countries, Proceedings of IEEE 2018 International Conference on Advances in Big Data, Computing and Data Communication Systems (ICABCD 2018), Durban, South Africa, August 6-7, pp. 222-227, ISBN 978-1-5386-3059-4.

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ABSTRACT

The problem caused by electronic waste is becoming more and more serious. Eliminating the rising amount of electronic waste in the world is currently the greatest challenge. Due to the toxicity of its components, electronic waste is gradually contaminating the environment. Mercury, cadmium, and chromium are a few examples of such dangerous chemicals. However, the depressing reality is that most people are uninformed about the detrimental effects of waste through electronics to the biosphere and well-being. Additionally, effective management of this waste by individuals is a challenge. Green information technology's ultimate aim is the elimination of the harm caused by insufficient handling and disposal of this type of waste.

Storytelling through a digital medium empowers by motivating and enabling society to become engaged with issues central to daily lives. It has been demonstrated that it can create and raise awareness in a variety of circumstances. Therefore, in this study, digital storytelling was employed to educate staff and students at higher education institutions about electronic waste and green information technology practices. The transformational paradigm, that is, critical social theory, was used in the study. According to the researcher, using this paradigm can improve individuals' lives with the correct intervention. To develop and carry out this study, action research was used as guiding approach. To build the digital story, design science research principles were used. The research problem was identified and categorised after a prior review of the literature and extensive qualitative data collection through staff and student interviews at South African higher education institutions. Using content analysis and critical systems heuristics, the interview material was coded and categorised, and themes were produced. The goal of the interviews was to ascertain the participants' initial levels of knowledge about electronic waste and environmentally friendly information technology practices. The next step was to conceive and produce a digital story with the intention of generating awareness. To view the digital story click here. After watching it, awareness levels were once again assessed through interviews to identify whether new awareness had been generated. Critical systems heuristics and content analysis were both used in the evaluation process.

In the context of this study, an oppressive structure is considered as a lack of education concerning devastating electronic waste effects. Higher education institutions in South Africa were empowered through awareness created by the digital story. Empowered higher education institutions in South Africa are likely to do justice to the environment by implementing green information technology practices. Critical social theory aims to both describe and address the problem. The problem was low levels of higher education institutions in South Africa and the

problem was addressed using a digital story. Thus, the study was guided by the critical social theory and discussion was provided on how the contributions of the study relate to the theory. Through critical awareness and methodological heterogeneity, the critical social theory paradigm promoted empowerment of higher education institutions in South Africa.

Keywords: awareness, digital storytelling, electronic waste, environment, green information technology

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- Baetellipele dithutong eleng Dr Imelda Smit and Prof Janet Liebenberg ka tataiso, tshehetso le kgothaletso ho fihlela qetellong, *“Ne ke tlaba wa mang ntle le lona?”*
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LIST OF ABBREVIATIONS AND ACRONYMS

3Ps	People, Planet and Profit
AR	Action Research
CO_2	Carbon Dioxide
CSH	Critical Systems Heuristics
CST	Critical Social Theory
DELL	Digital Electronic Link Library
DS	Digital Storytelling
DSR	Design Science Research
e-Learning	Electronic Learning
e-Mail	Electronic Mail
ERP	Extended Producer Responsibility
EU	European Union
E-waste	Electronic Waste
GIT	Green Information Technology
HEIs	Higher Education Institutions
HP	Hewlett Packard
IBM	International Business Machines
ICT	Information Communication Technology
IT Services	Information Technology Services
IT	Information Technology
ITTs	Information Technology Technicians
Mt	Million Metric Tonnes
NCV	National Certificate Vocational
NWU	North-West University
OECD	Organisation for Economic Co-operation and Development
SA	South Africa

SAP	Systems Applications and Products in Data Processing
TVET	Technical and Vocational Education and Training College
UoT	University of Technology
UPS	United Parcel Services
USA	United States of America
USD	United States Dollar
WEEE	Waste Electrical and Electronic Equipment
ZAR	South African Rand

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Abalansa, El Mahrad, Icely and Newton (2021:1) posit that electronic waste is continuously being managed in a way which is harmful to the environment. Studies conducted in South Africa and elsewhere, suggest that a lack of awareness regarding harmful effects of electronic waste to the environment intensifies the problems created by electronic waste (Ali & Akalu, 2022:2; Heeks, Subramanian & Jones, 2015:654; Miner, Rampedi, Ifegbesan & Machete, 2020:4). People are not sufficiently aware of the dangers of electronic waste and green information technology practices (Ali & Akalu, 2022:1; Alziady & Enayah, 2019:1; Maphosa, 2021:563). Therefore, the implementation of measures that promote management of electronic waste in a friendly way is necessary (Cordero, Juiz, Mory, Bermeo & Andrade, 2022:65636; Daum, Stoler & Grant, 2017:15).

Green information technology refers to all initiatives and measures geared towards designing, manufacturing, using and disposing information technology equipment in a manner that is friendly to the environment (Ojo, Raman & Downe, 2019:246), and is viewed as a promising approach towards proper management of electronic waste (Ribeiro, Tommasetti, Gomes, Castro & Ismail, 2021:1; Tamanna & Iqbal, 2020:45). Green information technology activities include minimising the use of hazardous toxic materials in the production, design of information technology devices, increasing energy efficiency throughout the course of devices' lifetimes, and lowering carbon footprints (Aini & Subriadi, 2022:651; Benamer, Elberkawi, Neihum, Anwiji & Youns, 2021:2). However, these measures can only be utilised when people are aware of the harmful effects of electronic waste and the advantages of green information technology.

Higher education institutions have low levels of awareness about the harmful effects of electronic waste in the environment and on health (Kitila, 2015:319; Maphosa, 2021:563; Ozdemir, Aydın & Kiraz, 2019:107), yet higher education institutions educate and teach the next generation of leaders. Young leaders in higher education institutions learn about technical subject matter, how to conduct themselves in the world, and how to treat the environment (Olo, Correia & Rego, 2021:2). Therefore, the greater society will benefit if higher education institutions are able to practice, embody and, hence, promote fundamentals about electronic waste and green information technology, and pass this crucial knowledge on to the next generation.

Since digital storytelling combines the art of storytelling with interactive media tools; it is a powerful tool to create awareness and transfer knowledge (Grant & Bolin, 2016:44; Park, Forhan & Jones, 2021:16). This study will employ digital storytelling to create awareness of electronic waste in higher education institutions.

The chapter is structured as follows; in Section 1.2, the concepts central to the study are introduced. A discussion of the problem statement and motivation for the study follows in Section 1.3. The objectives are listed in Section 1.4, and the design of the research is discussed in Section 1.5. In Section 1.6, ethical considerations are presented, and in Section 1.7, the study's contribution to the knowledge corpus is discussed. Section 1.8, supplies the layout of the chapters, whereafter the work in the chapter is summarised in Section1.9.

1.2 Concepts central to the study

A brief discussion of the major ideas at the heart of this investigation follows. These ideas are digital storytelling, electronic waste, and green information technology. This research makes the case that HEIs may practice, embody, and hence promote the foundations of e-waste and GIT and impart this knowledge to the next generation to the benefit of society. Because it skilfully integrates the art of storytelling with interactive media technologies, digital storytelling is selected as a technique. It is a potent instrument for conveying knowledge and generating awareness. (Grant & Bolin, 2016:44; Park *et al*., 2021:16).

1.2.1 Electronic waste

Any electrical or electronic device or component that has been abandoned by the owner without any thought of reuse is referred to as electronic waste (Parajuly, Kuehr, Awasthi, Fitzpatrick, Lepawsky, Smith, Widmer & Zeng, 2019:9). The European Union (EU) categorises e-waste into 10 categories and takes a more comprehensive view (Forti, Baldé & Kuehr, 2018:15; Gaidajis, Angelakoglou & Aktsoglou, 2010:193).

Information and Communication Technology is the name of the third category, which covers telecommunications and information technology (IT) equipment (Andersen, 2022:19923; Forti *et al.*, 2018:15; Widmer & Lombard, 2005:439). In the context of this study, any abandoned electric or electronic product, regardless of the use state, is called e-waste. According to the EU definition, this study focuses on the third category. When an information technology product no longer meets the demands of the user, it is considered to be e-waste (Miner *et al.*, 2020:2). According to the research, HEIs are unaware of the environmental risks associated with electronic waste (Maphosa, 2021:563; Ozdemir *et al.*, 2019:107). However, HEIs train and instruct the future leaders. The average lifespan of information technology items, such as desktop computers, printers, laptops, and computer servers, is rather brief (Fang & Rau, 2017:1; Widmer & Lombard, 2005:437; Ylä-Mella, Keiski & Pongrácz, 2022:1).

There are various reasons for this short lifespan. The world's expanding population and rising demand for IT units are two factors contributing to the relatively short lifespans of IT devices (Filimban, Al-Faraj & Oti 2019:325). Planned obsolescence by the manufacturers renders products obsolesce before their time. On the other hand, items are also becoming less robust, resulting in lesser quality products that soon become outdated (Bisschop, Hendlin & Jaspers, 2022:271; Malinauskaite & Erdem, 2021:727). The issue with outdated electronics is that they frequently end up as e-waste (Miliute-Plepiene & Youhanan, 2019:5). This is because they are frequently disposed of inappropriately, which leads to their winding up in landfills (on or into land) and contaminating the ecosystem, which has an adverse effect on people, animals, and the environment. An increasing concern of the twenty-first century, is the exponential rise of e-waste steadily harming the environment (Rama, Turaga, Bhaskar, Sinha, Hinchliffe, Hemkhaus, Arora, Chatterjee, Khetriwal, Radulovic, Singhal & Sharma, 2019:127). Global e-waste production was projected by Statista to have been 47.8 million metric tonnes (Mt) and 49.8 Mt in 2017 and 2018, respectively (Statista, 2020:1). In 2019, 53.6 Mt were produced globally, and it is anticipated that by 2030, 74.7 Mt will have been produced (Ankit, Saha, Kumar, Tiwari, Sweta, Rawat, Singh & Bauddh, 2021:1; Statista, 2022:1). Electronic waste production reached 55.5 Mt in 2020 worldwide. On average, the amount is increasing by 2 Mt annually. A total of 57.4 Mt of anticipated e-waste was produced in 2021 (Ruiz & The Roudup, 2022:1; Statista, 2022:1). In 2020, the market for recycling e-waste was estimated to be worth United States Dollar (USD) 49,880 million (Ruiz & The Roudup, 2022:1). It is estimated that in 2023 and 2024, 61.3 Mt and 63.3 Mt of e-waste will be generated, respectively (Statista, 2022:1).

According to estimates, 76% of the world's e-waste travels through unofficial channels, having serious negative effects on the biosphere and health. Surprisingly little is known about these flows and players in spite of this information (Davis, 2021:101). In 2019, only 17.4% of generated electronic waste was recovered and recycled (Cross, 2021:55; Ghimire & Ariya, 2020:154). This means that instead of being collected for treatment and reuse, recoverable substances, with a conservative value of USD 57 billion, were primarily discarded or burned (Forti, Baldé, Kuehr & Bel, 2020:15). This amount surpasses the gross domestic product of many regions (Murthy & Ramakrishna, 2022:2). Electronic waste units contain an array of both valuable and hazardous substances. Substances of value make up 61% of the total amount of metals in e-waste, along with plastics 20%, ceramics 2%, glass 5%, wood 3%, rubber 1%, and pollutants 5% (Van Yken, Boxall, Cheng, Nikoloski, Moheimani & Kaksonen, 2021:4). Mercury, cadmium, and chromium are only a few examples of such poisonous compounds that are bad for people (Singh, Duan &

Tang, 2020:3). Reducing e-waste through recycling is paramount. Proper management entails safely disposing of harmful chemicals and recycling valuable ones, or even recycling the entire unit (Delcea, Crăciun, Ioanăs, Ferruzzi & Cotfas, 2020:1; ITU, 2012:4).

Having a broken gadget does not necessarily signal that the piece is no longer usable. Instead, there may be a chance to extend the life of the entire unit; it might either be utilised for the same function by new users whose needs can still be met by it, or its parts and/or components could be reused (Ylä-Mella *et al.*, 2022:12). Therefore, it is critical to effectively manage and minimise e-waste (Naik & Satya Eswari, 2022:1). Anyone in charge of waste management must make sure that all waste, including electronic waste, is safe for both humans and the environment. Every South African is guaranteed fundamental human rights under the South African (SA) Constitution (Act 106 of 1996). As a result, it is prohibited to burn any component of e-waste outside due to the poisonous smoke it produces (Ozdemir *et al.*, 2019:102). Electronic waste and a lack of knowledge thereof are global issue.

Research throughout the world and in SA has been documented (Dayaday & Galleto, 2022:534). Despite initiatives taken to minimise e-waste, HEIs still struggle with the paucity of framework(s) to handle e-waste. The laboratories are entangled in the crisis of waste (Kitila & Woldemikael, 2019:30). With funding from parastatal organisations, South African universities and universities of technology frequently work on waste management initiatives (Rapulane, 2018:1; Widmer, Oswald-Krapf & Sinha-Khetriwal, 2005:437). Universities continue to be among the biggest e-waste producers in SA and internationally (Kiplagat, Odero & Buigutt, 2017:235; Maphosa, 2021:563). To guarantee effective e-waste disposal, HEIs need to be more aware of this dilemma (Ahmad, 2021:65; Kitila & Woldemikael, 2019:30).

1.2.2 Green Information Technology

Climate change, environmental harm from e-waste, and energy issues related to IT use are the main forces behind green information technology (GIT) worldwide and in SA. Maphosa and Maphosa (2020:1) contend that the GIT is insufficient for Africa. There is a wealth of material available that demonstrates how GIT should look (Debnath, Roychoudhuri & Ghosh, 2016:669). It is essential to put policies into place that encourage considerate handling of waste caused by electronic items (Cordero *et al.*, 2022:65636; Daum *et al.*, 2017:15). An effective approach to waste of this type is GIT (Ribeiro *et al.*, 2021:1; Tamanna & Iqbal, 2020:45). According to the literature, green information technology and electronic waste risks are not well understood, (Ali & Akalu, 2022; Maphosa, 2021). According to Abalansa *et al.* (2021:1), e-waste is constantly handled anti-environmentally. Evidence shows that the challenges with e-waste are made worse by a lack of knowledge about how electronic waste harms the environment (Ali & Akalu, 2022:2; Heeks *et al.*, 2015:654; Miner *et al.*, 2020:4).

However, there is a dearth of GIT literature that addresses the issues of waste linked to electronic items (Debnath *et al.*, 2016:669). Green information technology points towards a broad variety of topics and endeavours that are concerned with environmental sustainability and energy conservation. Energy-efficient computing, design for environmental sustainability, risk mitigation relating to the environment, regulatory compliance, and ethical recycling and disposal are a few of these (Benamer *et al.*, 2021:2). Additionally, GIT offers a thorough and useful perspective on the ecological effects of IT. It includes the following: (i) green initiatives include reducing the energy consumption of IT products and equipment, (ii) designing energy-efficient IT products and equipment, (iii) recycling obsolete IT products and equipment, and (iv) building IT products and equipment with little to no environmental impact (Alboqomi & Khan, 2021:118).

1.2.3 Digital Storytelling

In ancient times, storytelling served as a way of transmitting knowledge, information, customs, legacy, and history to future generations (Redding, 2020:357; Smeda, Dakich & Sharda, 2014:2). A new method of sharing stories has evolved in today's technologically advanced world, that is, telling stories digitally (James, Yong & Yunus, 2019:191; Malita & Martin, 2010:3061). The benefit of digital stories is that anybody can produce them, they may be about anything, and they can be instantaneously and electronically sent anywhere on the globe (Chan, 2019:2). According to published research, digital storytelling (DS), which blends the craft of storytelling with a variation of interactive media techniques, may be a potent instrument for raising and creating awareness and enhancing knowledge transmission in order to influence people's ensuing behaviours (Aljaraideh, 2020:77). To attain this study’s goal, this research investigates digital storytelling as a technique to build an intervention (digital story). Digital storytelling has multiple definitions; however, they converge on the fact that multimedia is a precursor in DS (Karantalis & Koukopoulos, 2022:4; O'Byrne, Stone & White, 2018:1; Rumanyaka & Galan, 2015:1).

As a result of the wide range of digital instruments, including computers, wireless technology, and scanners, which have all become comparatively accessible and inexpensive, digital stories can only exist in the digital realm (Dreyer, 2017:2; Dush, 2009:1). Digital media is used to create, store, and share digital stories (Rubio-Hurtado, Fuertes-Alpiste, Martínez-Olmo & Quintana, 2022:108). The employment of narratives in stories is referred to as storytelling (Choo, Abdullah & Nawi, 2020:46). They show characters, for instance, engaging in a string of dramatic occurrences from the beginning of the play until its conclusion (Sundin, Andersson & Watt, 2018:2). Eissa (2019:129) presented DS as “*latest variation to storyteller*". The author's command of the medium, particularly word choice, is highlighted with multimedia to process a compelling story for the audience (Abdel-Hack & Helwa, 2014:9; Sitter, Beausoleil & McGowan, 2020:2). The three main types of digital storytelling are individual stories, factual documentaries, and stories that inform or teach (Karantalis & Koukopoulos, 2022:5). Individual narratives encourage discourse concerning contemporary challenges (Balaman, 2018:204; Conrad, 2013:459). Factual documentaries teach people about events that happened in the past by, for example using artifacts. Furthermore, DS is accessibly priced and readily available as a tool (Sheafer, 2016:134). A DS is not necessarily an over-the-counter product. It is also freely available.

1.3 Motivation and problem statement

The apparent understanding paucity in relation to the negative impacts of e-waste, particularly around HEIs, is what inspired this investigation. There are huge amounts of waste in HEIs storages (Department of Environmental Affairs, 2015:1; Kitila & Woldemikael, 2019:39). Higher education institutions are accused of the untimely disposal of this waste (Coleman, 2016:67; Davis & Wolski, 2009:5; Dayaday & Galleto, 2022:534). Electronic waste is held in laboratories and lecture halls at HEIs for months before disposal, which can cause storage, health, and safety hazards (Morallo, 2016:34). Unaware of e-waste, one would assume that the majority of end-of-life products are either dumped in landfills as municipal waste or stored in risky locations (Alameer, 2014:388; Kapukha, Mbuguah & Kilwake, 2019:20). Electronic waste is a classic illustration of the worldwide environmental sustainability dilemma that humanity faces in the twenty-first century. It is a global issue; its volume is increasing, and it has a harmful impact on humans, animals, and the environment (Cotta, 2020:256; Janagam & Jeyamani, 2011:313). Electronic waste abandoned in municipal rubbish or stored in dangerous areas, as detailed by literature, is an example of incorrect management (Kitila & Woldemikael, 2019:30; Maphosa, 2021:562; Mathe, 2019:44; Priyashantha, Pratheesh & Pretheeba, 2022:2).

Given their purpose of engaging in activities that minimise ecological, economic, and societal repercussions, institutions, such as HEIs, must promote and execute GIT (Findler, Schönherr, Lozano, Reider & Martinuzzi, 2019:23; Suryawanshi & Narkhede, 2015:702). Sadly, HEIs are insufficiently aware of GIT (Mbewe, 2019:139; Thomson & Belle, 2015:173). As a result, HEIs have become one of the greatest contributors of waste from electronic devices because of their usage for teaching and learning (Kiplagat *et al.*, 2017:235). Higher education is a growing service sector (Olo *et al.*, 2021:2). The enormous number of enrolments at HEIs can be blamed for the rise in e-waste (Lauder & Mayhew, 2020:1; Putri, Hudirarto, Argogalih & Handimuljoredjo, 2015:232). Electronic waste management has become a concern for HEIs with regard to their environmental sustainability goals (Chibunna, Siwar, Begum & Mohamed, 2012:664; Maphosa, 2021:563; Tangwanichagapong, Nitivattananon, Mohanty & Visvanathan, 2017:204). Higher education institutions have a tremendous moral responsibility for the establishment of a fair and sustainable environment for a better tomorrow (Olo *et al.*, 2021:2).

Given the volume created and the environmental risks generated by this equipment, GIT is no longer an option. According to Ozdemir *et al.* (2019:101), a lack of understanding is a barrier to appropriate e-waste management in HEIs. A literature search reveals a paucity of in-depth study on GIT practice (Dayaday & Galleto, 2022:534; Maphosa, 2021:563). The GIT and e-waste challenges thus have an impact on the HEIs' stakeholders. Stakeholders are defined as groups *"in relationship with an organisation"* (Benn, Abratt & O'Leary, 2016:1). On the other hand, a stakeholder is also a person or entity that has the potential to or is already having an impact on the achievement of an organisation's goals (Freeman & Reed, 1983:91; Savga, Krykliy & Kyrychenko, 2018:32). Higher education institutions, like every other organisation or institution, have stakeholders (Labanauskis & Ginevičius, 2017:64). Students, IT employees, and administrative staff are all stakeholders in higher education institutions (Okai-Ugbaje, Ardzejewska & Imran, 2020:2; Yang & Li, 2020:8). Students, staff, vendors, and government officials are examples of internal (main) and external (secondary) stakeholders at higher education institutions (Seres, Maric, Tumbas & Pavlicevic, 2019:9056). The primary stakeholders are those whose continued contribution to the organisation is vital and without which organisations would not survive (Clarkson, 1995:106; Miragaia, Ferreira & Ratten, 2017:46).

Due to their scholarly work at HEIs, students and faculties may be regarded as internal stakeholders. Students, as consumers and workers (faculties) as service providers (of education) are HEIs' life source. Higher education institutions cannot survive without their continued engagement (Degtjarjova, Lapiņa & Freidenfelds, 2018:392; Jongbloed, Enders & Salerno, 2008:305). According to Yang and Li (2020:7), students are a critical component of every educational framework. Employees and students at HEIs are thus stakeholders since they are likely to impact or be affected by the organisation's stake. Students and faculty cannot be viewed as placeholders, and they are both completely qualified to engage in this study.

Therefore, for this study, the researcher carried out a literature search by systematically analysing extensive amounts of literature, using software for computer-aided qualitative data analysis (Saldaña, 2009:23; Soratto, Pires & Friese, 2020:2). The results of the literature search displayed no results similar to this study. To justify the study, the researcher will go deeper, utilising qualitative data gathering methods to validate the level of the participants' knowledge of the sustainability in HEIs. The study will determine a benchmark against which to measure increased awareness after showing participants the digital story. The researcher will seek to create awareness, using DS as a strategy or tool and will assess whether awareness was created following the intervention.

The escalating e-waste generated worldwide yearly, and associated dangers to the environment and well-being are threats to humankind when mismanaged. Literature has shown that people are unaware of the dangers of e-waste and proper management thereof (Ozdemir *et al.*, 2019:101). The problem to be investigated was the perceived low level of e-waste awareness in HIEs that needs to be addressed.

1.4 Study objectives

Aims are described and classified as primary, as well as secondary objectives.

1.4.1 Primary objective

The fundamental objective of this research is to determine and create awareness of electronic waste and green information technology practices at HEIs in SA.

1.4.2 Secondary objectives

The study's secondary objectives have been divided into theoretical and empirical objectives. They are described in more detail below.

1.4.2.1 Theoretical objectives

Through literature reviews, the theoretical aims are developed to acquire knowledge regarding the study's fundamental principles, such as:

- The literature on key concepts in the research, such as e-waste, GIT, and DS, were examined and discussed, building a shared understanding.
- Research paradigms and techniques were investigated and debated to comprehend and motivate the chosen paradigm and approach.
- The chosen research paradigm, as well as processes were described to define their use in this study.

1.4.2.2 Empirical objectives

The empirical element of this study was conducted under the critical social theory (CST) paradigm, with the iterative action research (AR) phases of diagnosing, action planning, action taking, evaluating, and describing learning being followed (Baskerville, 1999:13; Saarikallio & Tyrväinen, 2022:4). They are briefly discussed next:

- The purpose of the diagnostic phase was to establish SA HEIs current levels of awareness about the problem.
- The goal of the action planning phase was to develop the intervention (digital narrative). The intervention was developed through DSR principles and Kadjer's approach (Brocke et al., 2020:2; Hevner & Chatterjee 2010:320; Kajder et al., 2005:45).
- The aim of the action-taking phase was to engage participants in the developed digital story.
- The aim of the evaluation phase was to study the consequences of the action taken in the action-taking phase.
- The aim of the specifying learning phase was to identify the general findings resulting from the previous phases.

The action research phases described above were repeated in each case (higher education institution), except when developing the digital story – which was carried out in a single case. In this study, a single AR cycle was implemented.

1.5 Research design

If a researcher did nothing more than gather and present facts without offering a context for knowledge, the research cannot provide a whole story (Sanda, Anigbogu, Izam & Nuhu, 2021:28). Using case studies presented an opportunity to provide context in search of a whole story (Rashid, Rashid, Warraich, Sabir & Waseem, 2019:2).Yin (2003:2) maintains that the case study technique enables the research of real-life events to retain comprehensive and significant aspects. There are many definitions of a case study. A case study is a detailed description and examination of a constrained system (Takahashi & Araujo, 2020:102). According to Merriam (2001:28), a case study can further be defined by its special features, namely that it is characterised as being particularistic, descriptive and heuristic. Particularistic refers to the case study's emphasis on a specific circumstance, incident, activity, or phenomenon. Descriptive case studies produce a thorough, thick description of the phenomenon they are studying. Case studies are heuristic in the sense that they help the reader comprehend the phenomenon being studied (Merriam, 2001). Alpi and Evans (2019:2) further states that a case study is a method where an investigator studies a real-world, contemporary bounded system or many bounded systems over a certain period, executing extensive data collecting from various corpora of information. A single person, a group, an occasion, a structure, or any other occurrence in which the researcher is interested can all be referred to as a bounded system (Coombs, 2022:2).

This study centres around four HEIs. According to Kekeya (2021:28), a case can be an individual, a family, organisation, community or household. Therefore, in this study a case was HEIs. The utilisation of several case studies typically results in a more engaging narrative and more robust research (Priya, 2020:100). The multiple case study technique enabled the researcher to gather and analyse data from several cases, which helped the researcher to predict a literal replication (predict similar results) and/or theoretical replication (predicts contrasting results, but for predictable reasons) (Neubert & Halkias, 2020:49; Yin, 2003:47). Multiple cases provide the researcher with the opportunity to mobilise knowledge from individual cases (Khan & Van Wynsberghe, 2008:1). Mobilisation of case knowledge occurs "*when researchers accumulate case knowledge, compare and contrast cases, and in doing so, produce new knowledge*" (Khan & Van Wynsberghe, 2008:1). Furthermore, cross-case analysis allows the researcher to compare cases from one or more context, communities, or groups (Khan & VanWynsberghe, 2008:2). In this study, the researcher compared four cases from different HEIs.

1.5.1 Research approach

The researcher mixed complementing approaches for various phases of the research; done holistically and from a CST viewpoint. Through critical awareness and methodological heterogeneity, the critical social theory research paradigm promoted emancipation (Bailie, Cunningham, Abimbola, Laycock, Bainbridge, Bailie, Conte, Passey & Peiris, 2022:2). The empirical work was complemented by structuring the research within a framework that positions AR in the CST paradigm (Checkland & Holwell, 1998b). During the diagnosis phase a literature review was conducted, and semi-structured interviews and auto-photography was used to gather data to determine the extent of the problem for the study. Literature research on DS as well as designing and producing a digital story was carried out during the action planning phase.

Principles from design science research (DSR), were applied to develop the digital story (Brocke, Winter, Hevner & Maedche, 2020:2; Hevner & Chatterjee 2010:320). During the evaluation phases semi-structured interviews were again conducted to determine raised levels of awareness after the viewing thereof. In the next sections the procedures used for the literature review, research paradigm and techniques, data collection, data analysis, and method rigour and evaluation of the method are described.

1.5.2 Literature review

Reading relevant material gave greater insight into pertinent arguments about e-waste and GIT, as well as implementing DS in a different context. The study's key phrases were utilised as a search criterion for information regarding the study's problem statement, and literature was gathered from sites, such as:

- Academic publications and papers including those found in databases that are electronically accessible through the university library catalogue.
- Theses, as well as dissertations
- Academic manuscripts

1.5.3 Study structure

The research is organised around the paradigm established by Checkland and Holwell for performing AR, as well as from a CST standpoint (Checkland & Holwell, 1998a:13; Molineux, 2018:30). An action research study had three basic components: to resolve/improve the area of concern (A), the researcher employed a collection of connected concepts, with the framework of concepts/philosophical basis (F) implemented by means of a methodology (M) (Checkland & Holwell, 1998b). Figure 1-1 shows an illustration of these three elements; the researcher involved in a research process may learn about all three elements.

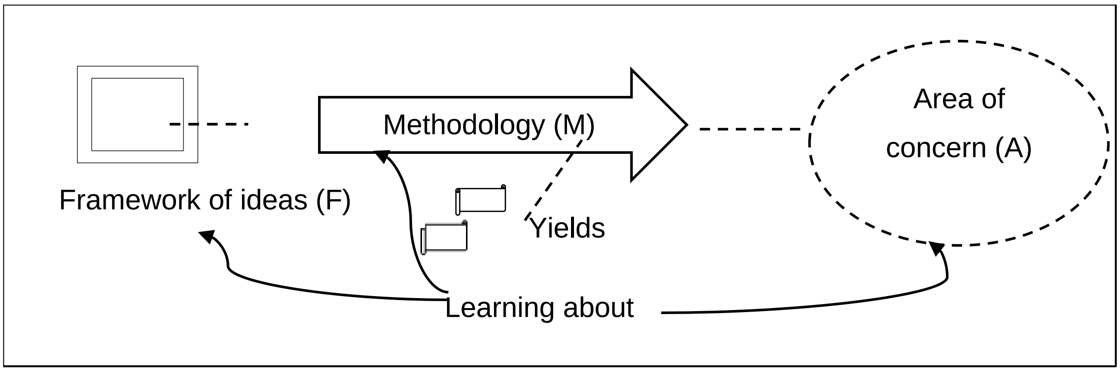


Figure 1-1: The action research process illustrated (Checkland & Holwell, 1998b)

To address A, namely creating knowledge of GIT practices for disposing of e-waste at HEIs a digital story was employed. Positioned within the CST paradigm as F, is critical systems heuristics (CSH), utilised as a technique (M) for systems thinking. Critical social theory was chosen as a paradigm because it facilitates awareness and emancipation (Reynolds, 2011:39). The three foundations of CST are emancipation, awareness, and pluralism. Critical social theory also incorporates CSH's ideas: links between impacted partners involved; change through input, output, feedback, development, and collaboration; issues to be regarded as systems; control, identity, environment, emergence, and hierarchy (Mahmoud, Jerneck, Kronsell & Steen, 2018:3). The principles of emancipation via methodological pluralism/complementarity and critical awareness form the foundation of the CST paradigm (Bailie *et al.*, 2022:2; Jokonya, 2016:858). Pluralism emphasises examining events from a variety of different points of view before combining diverse systems frameworks, methodologies, and models as necessary (Bailie *et al.*, 2022:2; Jokonya, 2016:857). This study was guided by the CST paradigm in terms of complementarity, critical awareness, and liberation as follows:

- ***Empowerment or emancipation***: In the context of this study, oppressive structure is considered as a lack in education concerning devastating electronic waste effects. Awareness creation translates to empowerment.

- ***Critical awareness***: When participants are empowered, they are likely to do justice to the environment in terms of implementing GIT practices.

- ***Complementarism:*** Critical social theory aims to both describe and address the problem. The research aim used a digital story to tackle the research problem. To attain the empirical goal, the researcher additionally used supplementary research approaches during the empirical study and AR stages.

1.5.4 Research paradigm and methodologies

In this section, the CST paradigm is defined, and the research methodology used in this study is briefly described.

1.5.4.1 Critical social theory research

Critical social theory researchers, like interpretivist researchers, recognise that research is not value free. However, unlike interpretative researchers, they seek to transform society rather than simply comprehend it (Harvey, 2022:148; Lee, Wong & Chong, 2011:129; Renault, 2016:18). The CST paradigm is adaptable enough to accommodate any methodology or technique that might help to rectify the imbalanced social structure (Asghar, 2013:3123; Omodan, 2022:278; Prince & Levy, 2017:8). Critical social theory potentially sees IT as a means of achieving freedom. (Bednar & Welch, 2012:144; Fuchs, 2017:2431).

1.5.4.2 Action research

Action research is a cyclical process and a participatory endeavour that engages with challenges and learns in the process of effecting change (Drummond & Themessl-Huber, 2007:430; Song & Li, 2014:287). The cases in this study where a single AR cycle was implemented are the following: traditional university, a university of technology, and two technical and vocational education and training (TVET) colleges. Traditional universities provide general formative and professional academic programmes, including undergraduate, Master's, and PhD graduate programmes. Universities of technology mainly focus on offering undergraduate programmes that emphasise careers (Department of Higher Education and Training, 2019:3). To develop the skills required by the economy and, consequently, for the sustained economic growth of a nation, TVETs are crucial.

Students who are in grade nine may continue their education until grade twelve and graduate with the National Senior Certificate. They can also go on with their vocational education at a TVET (Kühn, 2019:227). Technical and Vocational Education and Training Colleges aim to be high quality adaptive systems. To finally meet its objectives for human resources, the government of South Africa employs this system to encourage the union of education and training, as well as the improvement of learner mobility and progression. Technical and Vocational Education and Training College systems are created to meet these demands and advance the social, civic, economic, and personal growth of the nation (Aina & Ogegbo, 2022:131). Their goal is to provide individuals with intermediate to advanced skills that will serve as a basis for further education ease the transfer from school to the workplace and foster independent lifelong learners (Oosthuizen, Spencer & Chigona, 2022:215; Shi & Bangpan, 2022:2).

1.5.4.3 Design science research

The ideas of DSR seek to create novel artefacts of IT (Coetzee, 2019:290). Design science research aims to create and evaluate IT artefacts, for instance, to address organisational problems (Hevner, vom Brocke & Maedche, 2019:3). According to the paradigm of design science research, the world’s actual problems are solved by creating innovative artefacts, therefore adding to the corpus of scientific data. (Aburamadan & Trillo, 2020:217; Engström, Storey, Runeson, Höst & Baldassarre, 2020:2630). It was therefore suitable to incorporate DSR principles in this study.

1.5.5 Study participants

The participants in this research were mainly employees (information technology technicians in particular) and students. At university, the participants were students and information technology technicians (ITTs). In TVET colleges, participants are students and ITTs in the second TVET college. The participation of ITTs as participants is determined by their roles and duties in their individual institutions, such as appropriately disposing of e-waste. One compelling argument for including students as participants is that research demonstrated that students had a poor degree of knowledge about e-waste risks to the environmental (Antolo, Concemino, Emano, Macabecha, Monreal & Galarpe, 2017:76; Azodo, Ogban & Okpor, 2017:1039). Nonetheless, the majority of students entering HEIs are proficient mobile phone and computer users (Ahmad, 2020:27). Most students at HEIs have cell phones and laptop computers (Aheto & Cronje, 2018:93; Goundar, 2014:210). As a result, they must learn how to properly dispose of old or obsolete IT equipment or gadgets.

1.5.6 Data gathering methods

Data was mostly gathered through semi-structured interviews. The interviews were accompanied by auto-photography (Glaw, Inder, Kable & Hazelton, 2017:1; Morgan, 2022:64). According to Glaw *et al.* (2017:1) auto-photography is a successful visual data collection methodology that uses visuals. A qualitative research may be anticipated to collect data from several (at least two) sources in order to achieve convergence and corroboration via the use of various data sources and methodologies (Bowen, 2009:28; Dalglish, Khalid & McMahon, 2020:1425). For triangulation purposes interviews were coupled with auto-photography. Triangulation in a research context refers to the combination of methodologies in the study of the same phenomenon (Natow, 2019:160). Data was gathered from the participants in the diagnosing and evaluation phases of AR.

1.5.7 Analysing data methods

Content analysis in combination with Ulrich's operational set of 12 questions, called CSH, was used for analysis in the diagnosing and evaluation phases. Content analysis is a process of categorising text into groups of related categories to detect similarities and differences, patterns, and correlations, both on the surface and implied within the text (Kleinheksel, Rockich-Winston, Tawfik & Wyatt, 2020:128). Content analysis is distinct in that it may be applied both quantitatively and qualitatively (Kleinheksel *et al.*, 2020:128). Factual text is offered in the form of frequencies. Facts collected from text are offered in frequency forms and were presented as percentages in quantitative content analysis. (Carmona, Baxter & Carroll, 2022:2). Data are given in words and according to themes in qualitative content analysis, allowing the researcher to depict results in depth in, for example, text passages and to seek to answer questions (Shava, Hleza, Tlou, Shonhiwa & Mathonsi, 2021:2454). The data in this study was also analysed quantitatively to supplement the qualitative content analysis and data interpretation (Kleinheksel *et al.*, 2020:128; Krippendorff, 2004:87; Obermair, Dodd, Bonner, Jansen & McCaffery, 2018:2). Generation of codes and themes will be systematically derived at with the assistance of Archive for Technology, Lifeworld and Everyday Language.text interpretation (ATLAS.ti) software for qualitative data analysis (Saldaña, 2009:28; Soratto *et al.*, 2020:2).

Critical systems heuristics rely on boundaries in support of social constructs that we use to build and evaluate any human action system of interest (Córdoba-Pachón, 2020:3; Reynolds, 2007:101). These boundary decisions capture critical components of any purposeful system of interest (Prus, Nacamulli Raoul & Lazazzara, 2017:2; Reynolds, 2007:105). Critical systems heuristics attracts a variety of elements that other assessment approaches may unintentionally overlook (Johnstone & Tate, 2017:2; Reynolds, 2007:105). The responses to CSH questions elicit substantial contemplation and spark conversation about many elements of situational change.

1.5.8 Rigour and evaluation of the method

Five principles are used to validate AR as suggested by Heikkinen, Huttunen, Syrjälä and Pesonen (2012:9), namely the principles of workability and ethics, evocativeness, reflexivity, historical continuity, and dialectics. In this study, the five principles were employed to validate the research. This study acknowledges the duty to be professional in research methods and to assure the study's validity.

1.6 Ethical considerations

The following ethical issues were considered in this study. Especially in studies that involve human participation ethical issues are a major concern (Monday, 2019:22). The cornerstones of a civilised society are ethics and ethical behaviour, sometimes referred to as *responsible practice* (Sivasubramaniam, Dlabolová, Kralikova & Khan, 2021:2).

- **The principle of autonomy**. The concept of autonomy necessitates that participants be given enough information to make an informed decision about whether or not to participate in the study. (Newman, Guta & Black, 2021:4). Participants must give informed consent before participating in a research study (Xu, Baysari, Stocker, Leow, Day & Carland, 2020:2).

- **Ensuring beneficence**. This means to do no damage and offer no danger to maximise potential advantages while minimising potential harm (Vanclay, Baines & Taylor, 2013:245; Varkey, 2021:18). Participants' well-being was respected and secured. Any information disclosed by the participants in the study was protected and not exploited. The researcher considered the circumstances of each participant, such as helping a disabled participant (Mondragón Barrios, Martínez Levy, Díaz-Anzaldúa & Estrada Camarena, 2022:391).

- **Ensuring confidentiality and anonymity of participants**. Participants' raw data needs to be safeguarded so that it cannot be traceable to an individual or institution. This can be achieved by publishing aggregated results (Badampudi, Fotrousi, Cartax & Usman, 2022:3).

- **Reporting the study results responsibly and ethically**. It is the ethical responsibility of the researcher to report the study findings involving humans as participants. There is more than one reason why findings are published. One of these is to contribute to the advancement of knowledge or science (Bahl & Bahl, 2021:584).

1.7 Contributions of the study

- Empirical contributions provided insight into processes of awareness creation under the Framework, Methodology and Application (FMA) model of Checkland and Holwell (1998a:13). Very little is known about CST and its relationship to awareness creation. The researcher used CSH's framework and content analysis to evaluate the intervention and reflect on the study's findings.

- The theoretical contribution was that learning may be obtained by applying a philosophical framework of ideas (F) to answer the problem (A) utilising methodology (M). A theoretical framework, namely CSH positioned inside the CST paradigm was utilised to lead the study in terms of interviews, construction of the digital story to empower, and evaluation of its influence on the participants after seeing it. This study also displayed the use of CSH in a unique area to drive this research. The following study-related concepts, namely electronic waste, green information technology, and digital storytelling were better understood through literature reviews. The subsequent sections show the classification of the chapters for this study.

1.8 Classification of the chapters for the study

In this section, the study outline and classification of chapters are presented.

Chapter 1: Introduction

Prominent ideas are introduced with a summary of the methodology, objectives, motivation, significance of the study and its relevancy. The problem statement and its major concepts are introduced in this chapter.

Chapter 2: Electronic waste

Electronic waste-related literature is examined. This includes the impact of e-waste on humans, animals, the biosphere, as well as treatment thereof. It concludes with typical methods for gathering, exchanging, and handling e-waste.

Chapter 3: Green Information Technology

In this chapter, key GIT-related literature is reviewed, and GIT implementation is advocated. Current hurdles confronting organisations eager to include GIT are addressed and GIT and how businesses may benefit from it are described.

Chapter 4: Digital storytelling

A study of key literary works for narrative and DS is presented. There is a discussion on how the development of story into DS was affected by technological improvements and an indication of how important DS and storytelling are to the investigation.

Chapter 5: Research methodology

The research methodology, data gathering and data analysis methods for this AR study were discussed. The researcher also explains why DSR should be used to build the intervention.

Chapter 6: Diagnosing the problem

In this chapter, there is a discussion and demonstration of how the problem is diagnosed to justify the continuation of this research. The data analysis approach used to produce themes from all four instances (cases) was also presented.

Chapter 7: Developing a solution

In this chapter, the study's action planning phase was explained. The creation and development of the digital story are discussed and there is a demonstration of how the strategy used to produce the digital story was applied, as well as the resources required. The action-taking stage of the AR process is also included. During this phase, the researcher explained how the digital story was shared with the participants.

Chapter 8: Testing the digital story

The learning phases of the AR process were specified and defined, and the lessons learned was evaluated. The AR evaluation and specification of learning phases concentrated on all four instances (cases) of the single AR cycle.

Chapter 9: Conclusion and recommendations

In this chapter, the investigation is concluded. The contribution to the knowledge corpus, recommendations, future research, and study limitations were provided. Principles to validate AR were discussed. The ethical issues were discussed, as well as how they were addressed.

1.9 Summary of the chapter

In the introduction, all the information required to inform the reader and to give him/her a clearer understanding of the nature of the research is contained. The following were addressed in the introduction chapter: the aim of the study, what motivated the study and the problem statement, the paradigm of the study (critical social theory), the context of the action research for the study, and the DSR that were used to create the digital story intervention.

The data gathering and data analysis methods for the study were explained, as well as an overview of the contribution of this study to the corpus of knowledge. Furthermore, there was an explanation of how important ethics are in this study (ANNEXURE C). There was an undertaking that ethical considerations would be upheld throughout the study. The concepts central to this study were discussed, namely electronic waste, digital storytelling, and green information technology. In conclusion, the chapters that collectively contributed to the attainment of the study’s aim were classified.

In the next chapter, a summary of previous research on electronic waste, one of the study's key ideas, is presented. The goal of a literature review on electronic waste is to gather information on the research and discussions that have been conducted that are pertinent to this study.

CHAPTER 2 ELECTRONIC WASTE

2.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

Humans rely much on information technology in both social and economic undertakings (Deb, 2014:25; Roztocki, Soja & Weistroffer, 2019:171; Verhoef, Broekhuizen, Bart, Bhattacharya, Qi Dong, Fabian & Haenlein, 2021:889). The unheard-of rate at which information technology tools are evolving resulted in a situation where manufacturers are unable to keep up with demands of consumers. Consumers want to have the latest technological advancements (Alias, Ishak, Zulkifli & Jalil, 2014:445; Shevchenko, Laitala & Danko, 2019:2). This scenario resulted in a situation whereby information technology products that may still be in good working condition are discarded by owners in the rush to obtain newer and better products (Kumar & Bhaskar, 2016:2; Taruna, Singh & Joshi, 2014:98). Market demands for information technology products also lured in new market players such as China who apparently manufacture and produce imitation products which are of low quality and therefore have short lifespans (Alias *et al.*, 2014:444; Butticè, Caviggioli, Franzoni, Scellato, Stryszowski & Thumm, 2020:5). With a compound annual growth rate of 11.6% the worldwide information technology market increased from United States Dollar 8,384.32 billion in 2021 to United States Dollar 9,358.51 billion in 2022. According to Gartner global information technology investment will increase by 5.1% from 2022 levels to United States Dollar 4.6 trillion in 2023. At a compound yearly growth rate of 8.8%, the information technology industry is anticipated to reach United States Dollar 13,092.49 billion in 2026 (CompTIA, 2022:1; The Business Research Company, 2022:1). All unused or discarded information technology products regardless of their condition are referred to as electronic waste (Panda, 2013:418; Parajuly *et al.*, 2019:9). Electronic waste is a global problem, due to its growing volume, and the negative impact on humans and livestock as well as the environment (Janagam & Jeyamani, 2011:313; Li & Achal, 2020:2). The generation of electronic waste is fuelled further by unserviceable electronic equipment and incompatibility of the old equipment with newly purchased accessories (Kumar & Holuszko, 2016:1; Wakuma, 2014:1165). Electronic waste is often generated in developed countries and shipped to developing countries for processing. Driving forces behind this e-waste shipments are strict e-waste regulations and the higher expense of recycling hazardous materials in wealthy countries (Ghimire & Ariya, 2020:155). Electronic waste problems in developing countries do not solely originate from the huge volumes shipped to them, but also by improper treatment methods, i.e. informal and insufficient recycling methods that are used (Miner *et al.*, 2020:2; Osibanjo & Nnorom, 2007:495). Electronic waste, when managed improperly, contaminates both air and water; which has devastating consequences for human health and livestock (Jaiswala, Samuel, Patel & Kumar, 2015:1320; Li & Achal, 2020:1). Various studies have shown that toxins released into the air or water, because of electronic waste, cause disorders e.g., skin diseases and under-development of the brain in children (Decharat & Kiddee, 2020:34; Janagam & Jeyamani, 2011:316). All of these are manifestations of inadequate knowledge and awareness of the negative impact of increasing electronic waste (Subhaprada & Kalyani, 2017:507). Electronic waste related toxic effects may exacerbated throughout a person's lifetime and across generations. Electronic waste therefore constitutes a significant global environmental and health emergency, with implications far broader than occupational exposure, also involving vulnerable groups in generations to come (Heacock, Kelly, Asante, Birnbaum, Bergman, Bruné & Buka, 2016:550; Rajesh, Kanakadhurga & Prabaharan, 2022:2). Electronic waste is wicked because it is not decomposable (Li, Wang, Kong & Yin, 2018:322; Panda, 2013:417). It is a major problem when it is buried into or lying above the ground, since the accumulation of toxic materials, e.g., cadmium, lead, etc., eventually contaminate the soil and water. The contaminated water accumulates in both rivers and underground water (Ferronato & Torretta, 2019:2; Kiddee, Naidu & Wong, 2013:1240). Contaminated soil and water, in turn, affect plants, animals and the living ecosystem, causing a range of severe health risks (Panda, 2013:417; Wang, Qian & Liu 2020:2). Unfortunately, large numbers of people involved in the electronic waste sectors are still not aware of the health and environmental risks posed by electronic waste (Dzah, O. Agyapong, W. Apprey, T. Agbevanu & K. Kagbetor, 2022:2; Ohajinwa, van Bodegom, Vijver & Peijnenburg, 2017:1).

An overview of electronic waste is given in Section 2.2, electronic waste production numbers are provided in Section 2.3, broken down by region, attention is drawn to managing electronic waste in Section 2.4, an explanation of how electronic waste harms the environment and people's health is given in Section 2.5, followed by a discussion on the continental management, commerce, and collection thereof in Section 2.6, with a final synopsis in Section 2.7.

2.2 Electronic waste overview

Humans nowadays rely heavily on information technology (IT) in both social and commercial endeavours (Deb, 2014:25; Roztocki *et al.*, 2019:171; Verhoef *et al.*, 2021:889). Because of the exceptional rate at which information technology tools are evolving, producers are unable to keep up with customer demands. Consumers expect to constantly have access to the most recent technical breakthroughs (Alias *et al.*, 2014:445; Shevchenko *et al.*, 2019:2). Market need for IT items has also attracted new market participants, which seems to manufacture and make copycat products with short lifespans and of low quality (Alias *et al.*, 2014:444; Butticè *et al.*, 2020:5). With the annual compound growth rate equal 11.6%, the worldwide IT market increased from USD

8,384.32 billion in 2021 to USD 9,358.51 billion in 2022. Global IT investment will increase by 5.1% from 2022 levels to USD 4.6 trillion in 2023. At a compound yearly growth rate of 8.8%, the information technology industry is expected to reach USD 13,092.49 billion in 2026 (CompTIA, 2022:1; The Business Research Company, 2022:1). The origin of waste generation lies with developed countries that maliciously ship this waste to the developing regions. Strict electronic waste regulations and high-end commerce transactions for local processing are the driving force behind e-waste shipments (Ghimire & Ariya, 2020:155). Electronic waste (e-waste) risks are not well understood, according to the literature (Ali & Akalu, 2022:1; Alziady & Enayah, 2019:4; Maphosa, 2021:563). According to Abalansa *et al.* (2021:1) e-waste is constantly handled anti-environmentally. Evidence shows that the challenges with e-waste are made worse by a lack of knowledge about how electronic waste harms the environment (Ali & Akalu, 2022:2; Heeks *et al.*, 2015:654; Miner *et al.*, 2020:4).

The problem of electronic waste in developing nations lies not only in the large volumes supplied, but also faulty treatment procedures that are utilised (Miner *et al.*, 2020:2; Osibanjo & Nnorom, 2007:495). Studies demonstrated that chemical emissions from electronic waste induce problems, such as skin ailments and brain underdevelopment in children (Decharat & Kiddee, 2020:34; Janagam & Jeyamani, 2011:316). This is a manifestation of insufficient awareness with regard to waste produced by electronics (Subhaprada & Kalyani, 2017:507). Toxic impacts can be amplified from individuals to upcoming generations. As a result, electronic waste is a major worldwide environmental and health issue, having ramifications far larger than occupational exposure and impacting vulnerable communities and future generations (Heacock *et al.*, 2016:550; Rajesh *et al.*, 2022:2). When poisonous items are buried or left above ground, they gradually pollute the soil and the water. Contaminated water collects in both rivers and subterranean reservoirs (Ferronato & Torretta, 2019:2; Kiddee *et al.*, 2013:1240).

2.3 Regional details of electronic waste

Even though governments are globally actively identifying the difficulties connected to e-waste and enacting laws, or regulations to manage it, a substantial quantity of electronic waste goes unreported after it reaches the state of being waste. Much of e-waste goes to underdeveloped and indebted regions. These nations lack completely functional recycling processes to handle this type of waste (Abalansa *et al.*, 2021:1). A large portion of the world's e-waste is gathering in open landfills in various African nations (Maes & Preston-Whyte, 2022:1). Large sections in Africa where imported e-waste is unsafely dismantled are found in Ghana and Nigeria (Lebbie, Moyebi, Asante, Fobil, Brune-Drisse, Suk, Sly, Gorman & Carpenter, 2021:1). First in the world's e-waste output is China, followed by the United States then Europe and Africa being the second least producer after Oceania (Ghimire & Ariya, 2020:155). Table 2-1 shows predictions on e-waste over the years to come.

Table 2-1: Outlook on electronic waste generation (Statista, 2022:1)

Period	Million metric tonnes	Period	Million metric tonnes
2021	57.4	**2026**	67.2
2022	59.4	**2027**	69.2
2023	61.3	**2028**	71.1
2024	63.3	**2029**	72.9
2025	65.3	**2030**	74.7

Table 2-2 depicts management practices of e-waste from selected regions in the Asia Pacific region.

Table 2-2: Electronic waste in the Asia Pacific region on in 2019 (Andeobu, Wibowo & Grandhi, 2021:5)

Region / Statistics	Produced waste (kilotons)	Produced waste (kg/capita)	Waste scheduled for Collection and Recycling (kilotons)	Implemented national legislation or regulations
Australia	554	21.7	58	Yes
China	10,129	7.2	1546	Yes
India	3230	2.4	30	Yes
Indonesia	1618	6.1	n/a	No
Malaysia	364	11.1	n/a	Yes

Table 2-3 displays unique components of e-waste.

Table 2-3: The unique components of electronic items (Andeobu *et al.*, 2021:5)

Contents / % in e-waste	Waste (%)
Metal	60%
Plastics	15%
Screens	12%
Metal-plastic mix	5%
Pollutants	3%
Circuit boards	2%
Cables	2%
Other	1%

Table 2-4 indicates the countries populous with waste produced by electronic items. Every day, the combined sites indicated above endanger about 200 million lives owing to e-waste health concerns (Wang *et al.*, 2020:4).

Table 2-4: Electronic waste polluted places in the world (Wang *et al.*, 2020:4)

Region / Actual sites	States that are sovereign	Unclean location
Asia	Russia	Norilsk; Dzerzhinsk
Asia	Ukraine	Chernobyl
Asia	China	Guiyu
Transcontinental (Asia and Oceania)	Indonesia	Kalimantan; Citarum River
South America	Argentina	Matanza Rischuelo River Basin
Africa	Zambia	Kabwe
Africa	Ghana	Agbogbloshle Dumpsite
Africa	Nigeria	Niger River Delta

2.4 Electronic waste (management)

Electronic waste leads to economic, administrative, and informational difficulties (Ghimire & Ariya, 2020:155; Wakuma, 2014:1168). Administrative obstacles include a lack of laws or a lack of organisational commitment to engage in green information technology (GIT) initiatives. Informative issues include a lack of awareness and information about the reasons for effective e-waste disposal. Economic problems centre around neglect of maintenance caused by insufficient infrastructure for recycling, a scarcity of experienced labour and limited commerce transactions for correct disposal. Electronic waste is all around us, and what counts is how it is handled and controlled.

2.4.1 Electronic waste crises and management thereof

Electronic waste issues are caused by three factors: (i) sheer volume: the volume of e-waste has reached unsustainable levels, (ii) global population: the global population is rapidly increasing and creating e-waste, and (iii) electronic waste is increasing at an annual rate of 4% to 5% (Miner *et al.*, 2020:1; Sthiannopkao & Wong, 2012:1148). Electronic waste must be controlled in one way or another. Transboundary movement is one method of dealing with it. The reasons behind the export of e-waste to other areas and continents is addressed in the following section.

2.4.2 Transboundary movement of electronic waste

Industrialised nations have large economies and superior technologies. Electronic waste is strictly regulated in industrialised countries (Cross, 2021:54; Ghimire & Ariya, 2020:155; Park, Hoerning, Watry, Burgett & Matthias, 2017:3). Because of the dangerous compounds included in e-waste, most European governments have prohibited its disposal in landfills (Green Peace International, 2009:1; Wang *et al.*, 2020:4). Furthermore, due to strict legal requirements and significant costs connected with recycling e-waste in industrialised nations, firms explored innovative methods of e-waste disposal (Terada, 2012:154; Wang *et al.*, 2020:4). Shipment activities to developing regions from the developed ones started in the early 1980's. The exodus of this waste was caused by governments of developed countries with strict requirements to manage the waste (Lakshmi, Raj & Jarin, 2017:33).

Organisations seeking permission to send this waste to underdeveloped nations prompted the shift. Electronic waste in underdeveloped nations is localised having been brought in from the developed nations. Movement between countries refers to the transfer of waste from one member country's or state's national jurisdiction to another member country's or state's national jurisdiction (OECD, 2009:11; Palmeira, Guarda & Kitajima, 2018:48). The fundamental reason why developing countries accept e-waste from wealthy countries is poverty (Cotta, 2020:261). Waste transportation from industrialised nations is enticing because of the low cost. Furthermore, shipping is not always carried out lawfully and ethically (Cotta, 2020:256). Some American and European corporations mislabel the contents of e-waste in order to improperly categorise the waste because the transportation of hazardous materials is not legally permitted in the respective nations (Daum *et al.*, 2017:8; Maes & Preston-Whyte, 2022:3). Non-industrialised countries see only the profits from materials of value (Maphosa & Maphosa, 2020:3; Sivaramanan, 2013:531). Scrapping equipment for precious resources and other reusable pieces is one example (Van Yken *et al.*, 2021:2; Witt, Urbaniak, Kaczorowska & Bożejewicz, 2021:2). To govern the transboundary transportation of e-waste, several national, international, and continental legislation and treaties exist. The Basel convention is one that should be mentioned (Cotta, 2020:260). The United Nations Basel Convention's goal is to address the issue of poisonous waste, especially e-waste (Amechi & Anoi, 2019:1). This pact was established for capping or controlling the transfer of hazardous waste products among nations (Peluola, 2016:1). Again, the pact prohibits trade with non-members and allows movement from regions without proper infrastructure (Peluola, 2016:1).

2.4.3 Electronic waste and theft of data

The ongoing movement of e-waste from industrialised to poor nations poses multifaceted risks, also data theft potential from abandoned electronic devices (Kapoor, Sulke & Badiye, 2021:3). Cybercrime is predicted to cost the world economy about USD 375 billion each year, with a growing proportion of cybercrimes emanating from West Africa (Doyon-Martin, 2015:207; Kshetri, 2019:77). Credit card numbers, bank account details, and other sensitive data are regularly left behind on computer hard drives and other storage media, and they could easily be used to commit crimes (Hedayati, 2012:9). In Ghana, where a subset of citizens has begun hunting for information on foreigners' old hard drives for extortion purposes, particularly major information security vulnerabilities have been brought on by an increase in e-waste traffic in Western countries. Producers of these gadgets IT goods should be more active in recycling as well, rather than relying entirely on recycling firms for the prior deconstruction of sensitive data (Abalansa *et al.*, 2021:12; Baylon & Antwi-Boasiako, 2016:9).

2.4.4 Electronic waste management in developing regions

Most developing countries do not prioritise GIT because of other national concerns, such as illiteracy, poverty, and illnesses (Ferronato & Torretta, 2019:1; Hanne, 2011:426; Park *et al.*, 2017:2). There is ample literature on commerce from e-waste as compared to emerging economies (Grant, 2019:6; Heeks *et al.*, 2015:654). Lack of infrastructure, insufficient funding, a lack of legislation, insufficient knowledge or education characterise poor e-waste management (Ali & Akalu, 2022:2; Bimir, 2020:660; Lebbie *et al.*, 2021:1). Almulhim (2022:1) goes on to say that good and relevant education and awareness are stepping-stones to a sustainable environment. A lack of education regarding the detrimental impacts of this waste translates to ineffective management (Miner *et al.*, 2020:2; Wakuma, 2014:1167). This is especially true for poorer countries, flooded by waste from most of the world big economies (Maphosa & Maphosa, 2020:2; Panambunan-Ferse & Breiter, 2013:193).

2.4.5 Electronic waste escalation in developing countries

In summary, the primary difficulties confronting developing countries that make effective handling and disposal of e-waste difficult, are the following:

- Amount of illegally trafficked waste by developed economies to emerging economies (Adanu, Gbedemah & Attah, 2020:2).
- The increased amount is ascribed to IT equipment's short life cycle, failing equipment while in use, high maintenance costs, comparatively inexpensive new items, and intentional obsolescence (Fang & Rau, 2017:1; Malinauskaite & Erdem, 2021:727).
- Ignorance about the toxicity of e-waste components in the developing world (Bimir, 2020:659).
- Information technology tool design problems and complexity make recovering useful parts from e-waste components challenging. Electronic waste is composed of several materials that have been bonded, soldered, or bolted together (International Labour Organization, 2012:12; Vermes, Tiuc & Purcar, 2019:7).
- There are limited initiatives and laws in the developing world that particularly address e-waste; often they are not enforced (Adanu *et al.*, 2020:1; Wath, Vaidya, Dutt & Chakrabarti, 2010:19).
- Cheap labour and poverty in developing countries (Oluwadamilola & Olubisi, 2021:5).

2.4.6 Electronic waste in South Africa

One of the Sub-Saharan countries that is falling behind in e-waste management is South Africa (SA), in comparison to industrialized nations like Japan, Germany, and Switzerland (Maphosa & Maphosa, 2020:4). In these nations, producers and municipalities coordinate the collection and recycling of e-waste through efficient policies (Maphosa & Maphosa, 2020:4). The traits that SA and other regions have in common are covered in the following paragraphs.

South Africa has her own e-waste challenges. According to a report by GreenCape, Williams, Barners, Tawanda and Smout (2017:38), SA produces her own share of e-waste in tonnes annually. The country is reported to export its share to other emerging economies (Sivaramanan, 2013:531). Exportation is attributed to a lack of adequate infrastructure for processing e-waste. One of the reasons for exportation is to take advantage of the stronger US currency during exchanges (Moyo, 2017:1). According to Ghosh, Debnath, Baidya, De, Li, Zheng, Awasthi, Liubarskaia, Ogola and Neiva Tavares (2016:694), SA's e-waste generated from old computers increased by 300% to 400% between 2007 and 2020. Electronic waste is being collected for recycling in SA by both the official and informal sectors. Regarding the disassembly, processing, repair, or recycling of e-waste by informal waste pickers, SA lacks data that is reliable (Schoeman & Ramutanda, 2022:2). About 360 000 tons of e-waste are produced annually in SA and barely 10 to 15% of this material is recycled. There's no model for addressing the e-waste issue in SA (Mouton, 2020:2). 9.7% of the e-waste produced in SA is recycled, with the valuable components being exported for recycling once it has been dismantled. This is viewed as a benefit. South Africa has a formal recycling sector for electronic waste supported by the informal sector. The majority (80% which amounts to 7500 tonnes) of electronic waste plastics remanufactured in SA are exported (Maes & Preston-Whyte, 2022:6). The age of the landfill, which prioritised disposal as the least favoured strategy in the hierarchy, is gradually giving way in the context of SA to local e-waste recycling (Moyo, Sadan, Lötter & Petersen, 2022:2). Currently, neither the formal e-waste recycling sector nor South Africa's e-waste economy are major employers or contributors and are estimated to be worth ZAR (South African rand) 24.3 billion annually. This is explained by the little amounts of e-waste that are now handled and the fact that most high-value metal processing takes place abroad. However, it is acknowledged that the sector offers a substantial employment potential when more e-waste is reprocessed, with an estimated 25 jobs/1 000 tonnes of treated e-waste (Moyo *et al.*, 2022:5).

2.4.7 Electronic waste and higher education institutions

The use of IT devices for both academic and administrative reasons is widespread at higher education institutions (HEIs) in developing countries and elsewhere. Higher education institutions should consider GIT for the benefit of the environment and their exponential dependence on use of these products (IT) (Dintoe, 2018:123; Elsaadani, 2015:10). According to Kitila and Woldemikael (2019:39) HEIs are engrossed with e-waste from IT equipment. The leading types of this waste in HEIs are not limited to computer boxes, monitors, and abandoned cables. Lack of understanding of the detrimental effects of this waste leaves HEIs with unaccounted volumes on their door steps (Shevchenko *et al.*, 2019:2). According to Freeman (2016:828), lack of education about this waste makes adoption of GIT at HEIs a futile exercise. The developed nations have long reaped the benefits of being aware of the dangers of e-waste. Education on this topic should be prioritised among people for the sake of the environment (Nwankwo, Olayinka & Ukhurebor, 2020:4378; Panambunan-Ferse & Breiter, 2013:189). Developing countries too should not be left behind in this race (Malik, Khan, Chofreh, Goni, Klemeš & Alotaib, 2019:14; Shittu, Gambari & Alabi, 2016:70). Electronic learning could, for example be used as a tool to transmit knowledge quicker, cheaper and in an environmentally friendly manner. The transfer of information for educational purposes using various media and IT is referred to as electronic learning.

Learning with electronic devices is defined as:

> *"Method of teaching and learning that fully or partially signifies the educational model used, based on the use of electronic media and devices as tools for enhancing availability of training, communication and interaction that helps in accepting novel ways of comprehending and establishing learning " (Elfaki, Ahmad & Abdelrahim, 2019:226).*

Green information technology techniques for HEIs are virtually unlimited (Franklin & Ismail, 2014:57; Ruiz-Mallén & Heras, 2019:3). The impediments to the implementation of GIT practices in HEIs are listed in Table 2-5 .

Table 2-5: Challenges of green information technology practices (Ara, 2018:44)

Barriers / Item No.	Impediments to green information deployment in higher education institutions
1	Inadequate funding and a lack of top-level assistance
2	Students, faculty, and staff exhibit minimal enthusiasm or engagement.
3	A corporate culture that is unconcerned about environmental problems
4	Green information technology is not well known.
5	Institutional education or training on GIT is lacking.
6	Information technology's environmental implications are underappreciated.
7	The government's lack of stringent regulation
8	Motivation is lacking among instructors, staff, and students.
9	An absence of competent procurement practices at HEIs
10	Insufficient research and development

Table 2-6 identifies studies that supports existence of limited research that deals with GIT practices or proper management of e-waste at the HEIs.

Table 2-6: Green information technology in higher education institutions

Other information / Paper key details	Year	Data collection method	Key findings
Vusumuzi Maphosa: Students' Awareness and Attitudinal Dispositions to e-Waste Management Practices at a Zimbabwean University	2021	online questionnaire	The findings indicate that most of the participants disposed of their electronic waste with the regular garbage. The participants noted that there were considerable impediments to e-waste management, including lack of policies, lack of collection places, and lack of recycling facilities.
Adeel, S; Nayab, A; Channa, K.A; Qureshi, M.U.: Students' Awareness of E-waste and Its Disposal Practices: A Conceptual Framework	2022	focus groups	Only students studying computer science are very knowledgeable about e-waste; the others have only a poor understanding of e-waste.
Raudha, A.M; Msolla, A.:/An Assessment of Factors Affecting Electronic Waste Management Within University Students' Environment	2021	questionnaires and documentation	The research found that there is little understanding about electronic waste management among university students. Additionally, research found that there is no budget set aside at the university for the handling of electronic waste, and there is no university policy to educate students about this issue.
Hernandez, A.A.: An Empirical Investigation on the Awareness and Practices of Higher Education Students in Green Information Technology: Implications for Sustainable Computing Practice, Education, and Policy	2019	survey questionnaire	The results suggest that students have an average level of awareness and unsatisfactory practices in Green IT. The results indicate the need to integrate Green IT in higher education curriculums to raise awareness among students and engage them in the sustainable use of computing resources.
Dayaday, M.G; Galleto, F.A.: Electronic Waste (e-Waste) Management of Higher Education Institutions in South Central Mindanao, Philippines	2022	survey	It should be emphasised that the annual production of e-waste by HEIs has a significant impact on the increase in the use of IT hardware and electronic gadgets. The key obstacles to effective e-waste management in the area are a lack of awareness, e-waste disposal facilities, priority, audit resolution and procedure, and a lack of clear regulations or laws among HEIs.
Research issues	Limited research that deals with GIT practices or proper management of e-waste at the HEIs is evident. More needs to be done to raise awareness about the hazardous effects of e-waste on the environment and health.		

2.5 Electronic waste impact on the biosphere and human well-being

Electronic waste has the economic benefit of combatting poverty, especially in countries in the southern hemisphere. The harm it can cause is measured in terms of the environment (Adediran & Abdulkarim, 2012:642; Akpan & Olukanni, 2020:1; Kiddee *et al.*, 2013:1247). A minimal quantity of the world's e-waste (about 12.5%) gets recycled effectively. The rest ends up in landfills, is burnt in the open air or is sent to impoverished or emerging nations (Burns, Sayler & Neitzel, 2019:10; Jaiswala *et al.*, 2015:1320). The environmental and health consequences of e-waste are examined next.

2.5.1 Environmental risks and the food chain

People are People are often surrounded by misinformation regarding e-waste (Kitila & Woldemikael, 2019:35). Environmental dangers from e-waste may be divided into three categories: land, air, and water (Hameed, Ali & Petrillo, 2020:3). In accordance with the literature, evil elements often seep into the earth, poisoning sources of life (Palansooriya, Shaheen, Chen, Tsang, Hashimoto, Hou, Bolan, Rinklebe & Ok, 2020:1). Furthermore, management flaws in e-waste components can have a detrimental occupational impact on employees involved in the waste's processing, as well as on the surrounding regions. Dangers to those who ply their trade in the informal sector emanates from contact (drinking polluted water and/or inhaling toxic smoke) with these evil elements (Fischer, Seidu, Yang, Felten, Garus, Kraus, Fobil & Kaifie, 2020). Electronic waste compounds may bioaccumulate in agricultural regions, where grazing livestock may ingest the poisons (Frazzoli, Orisakwe, Dragone & Mantovina, 2010:392). Toxins from electronic waste metabolise and bioaccumulate, therefore it is paramount to be cautious where animals feed (Boudebbouz, Boudalia, Bousbia, Habila, Boussadia & Gueroui, 2021:2). Figure 2-1 depicts the exposure paths of e-waste toxins in foodstuffs.

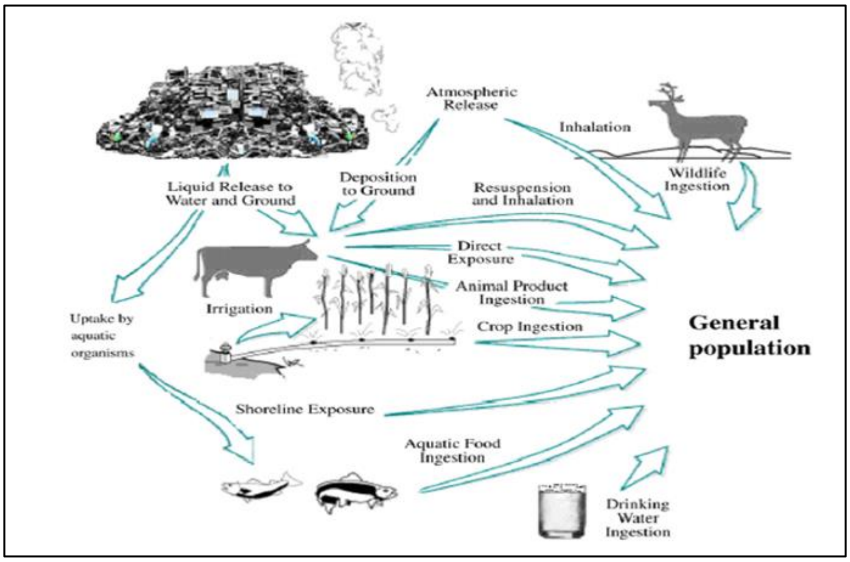


Figure 2-1: Electronic waste pollutants' exposure paths (Rajesh *et al.*, 2022:5)

2.5.2 Electronic waste and human health

Exposure to pollutants increases the likelihood of developing chronic illnesses, such as neurological problems (Dai, Xu, Eskenazi, Asante, Chen, Fobil, Bergman, Brennan, Sly, Nnorom, Pascale, Wang, Zeng, Zeng, Landrigan, Bruné Drisse & Huo, 2020:3). With contact from the polluted biosphere or food, such as meat, people may come into contact with harmful compounds (Adesokan, Adie & Osibanjo, 2016:27). Hazardous component exposure occurs through breathing, swallowing, and skin contact. People in underdeveloped nations frequently employ rudimentary ways to extract precious commodities, such as precious metals, like gold and silver. Cable burning and acid leaching are two rudimentary procedures utilised, both of which emit hazardous gases into the environment (Naik & Satya Eswari, 2022:2). Workers and residents in the nearby towns can readily inhale these. Toxic gases can have serious health repercussions. The utilisation of such crude element recovery procedures demonstrates insufficient GIT practice (Awasthi, Hasan, Mishra, Pandey, Tiwary, Kuhad, Gupta & Thakur, 2019:58). Table 2-7 displays the poisonous and dangerous compounds.

Table 2-7: Ecological and health implications of electronic waste (Ankit *et al.*, 2021:10)

Components / Environmental & health impacts	Serious health risks	Serious environmental dangers
Displays on computers	Phosphorous might be swallowed through screen glass cuts.	Contamination of water, especially groundwater
Circuit boards for electronics	Lead, tin, or brominated dioxin might all be inhaled accidentally.	Gas emissions pollute the atmosphere.
Gold-plated components and chips	Acid contact with biological components such as the eyes and skin might result in lasting damage. Inhaling acid vapours might cause respiratory issues.	Acidification of water sources can harm the area's flora and animals.
Materials made of plastic are used	Exposure to substances, like brominated dioxins and hydrocarbons	Infiltration of the environment, water, and soil
Motherboards that have been dismantled	Workers at disposal sites near residential areas are inebriated by tin and other heavy metals.	Degradation of water from underground supplies

Table 2-8 shows potential elements that are harmful and pose occupational health hazards.

Table 2-8: Elements causing occupational health issues (Rajesh *et al.*, 2022:5)

Pollutants that may exist	Dangers to one's health at work
Poly vinyl chloride emits dioxins and furans	Burnt (plastic) in the open, by-products cause immune system damage, developmental and reproductive issues are among the negative consequences.
Lead	The central nervous system, the cardiovascular system, and the nerves in the periphery are all harmed by lead.
Beryllium	produces beryllium illness and lung cancer when fumes are inhaled
Cadmium	Is a hazardous metal that has permanent consequences living matter. It builds up in vital organs.
Chemical element with Hg symbol	Mercury (from fish) causes respiratory problems.
Chemical element with Cr (VI)	Causes respiratory condition that leads to asthma.
Barium	Muscle weakening is caused by short-term exposure. Damage to heart, and spleen, for example
Brominated flame retardants	Interference with the activities of the endocrine system.

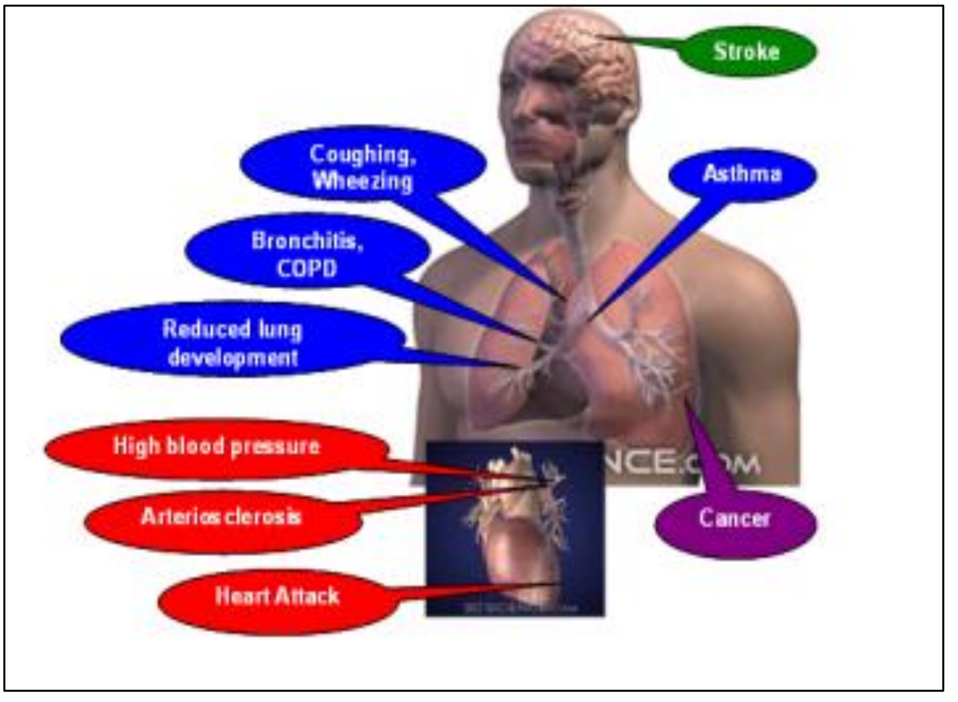


Figure 2-2: depicts consequences of heavy metals.

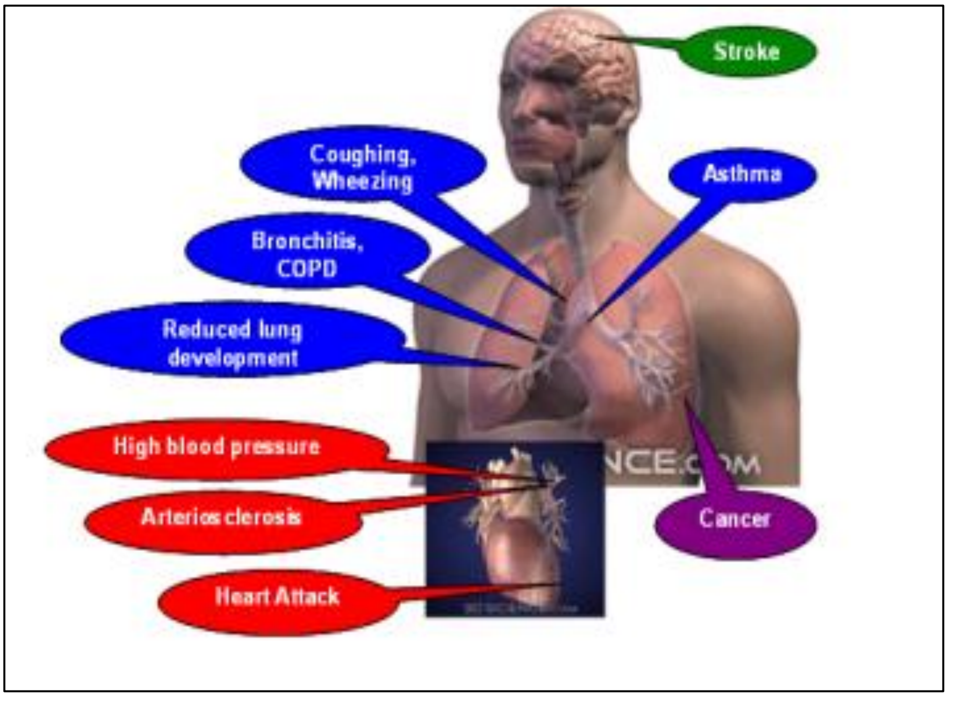


Figure 2-2: Heavy metals and human health (Li & Achal, 2020:5; Singh, Pal, Gangwar, Gupta & Tripathi, 2015:52)

According to studies, populations exposed to e-waste at uncontrolled or unregulated recycling facilities had higher levels of deoxyribonucleic acid damage than those further removed from these locations (Grant, Goldizen, Sly, Brune, Neira, van den Berg & Norman, 2013:353; Orisakwe, Frazzoli, Ilo & Oritsemuelebi, 2019:6). They discovered that individuals from e-waste affected neighbourhoods had worse lung function, and underweight new-borns were more frequent is a compilation of research that claims there is a lack of information and awareness about GIT and the adverse impacts of e-waste on people and the surroundings. Table 2-9 shows studies advocating the existence of limited knowledge about GIT.

Table 2-9: Research on the lack of knowledge about green information technology

Study / Author(s)	Findings
Okewu, Misra, Damaševičius, Damaševicius and Fernandez-San (2017:2) **(Ankit *et al.*, 2021:2)**	Given the insufficient understanding and knowledge about the detrimental effects (electronic waste) on the biosphere, it has a significant influence on both human wellness and ecosystems.
Osibanjo and Nnorom (2007:495), **Ghosh *et al.* (2016:695)** **(Abalansa *et al.*, 2021:2)**	Electronic waste is badly controlled, resulting in informal ways of recycling.
Decharat and Kiddee (2020:34) **Kiddee *et al.* (2013:1240)** **(Parvez, Jahan, Brune, Gorman, Rahman, Carpenter, Islam, Rahman, Aich, Knibbs & Sly, 2021:906)**	When e-waste is incorrectly dealt with it, harms water and soil, and creates health problems in people
Chugh, Wibowo and Grandhi (2016:436) **Kitila and Woldemikael (2019:35)**	Awareness along with knowledge of GIT procedures are either limited or non-existent.
Park *et al.* (2017:2) **(Ali & Akalu, 2022:2)**	People participating in the industry are unaware of the hazards involved. One of the most significant global barriers to e-waste management is a lack of understanding.
Adanu *et al.* (2020:1)	In countries that are still developing, there is little or minimal oversight of e-waste.

2.6 Electronic waste pickup and disposal

In the following section regular disposal procedures of e-waste such as official take-back schemes, e-waste disposal in mixed residual garbage, and informal e-waste collecting and recycling are discussed.

Municipalities, merchants, and commercial e-waste services are the primary collectors of e-waste in legally binding schemes. According to Grant (2019:14), in South Africa, take-back systems have yet to achieve much commercial revenues or success in competing with the thriving informal sector in door-to-door e-waste collecting. Screens, lightbulbs, and information and communication technology (ICT) equipment are among the types of e-waste collected. This e-waste ends up in cutting-edge treatment facilities where precious materials are retrieved. This e-waste is intended for the cutting-edge treatment facilities where precious materials are recovered. Electronic waste disposal in mixed residual garbage is a collecting procedure where waste is discarded in dustbins together with domestic rubbish. Therefore, it happens frequently that collected garbage is moved to a disposal location without first being separated. Depending on the location, the destination may be a municipal waste incinerator, a landfill, or both. Both an incinerator facility or landfill facility are considered appropriate disposal or handling procedures (Ferronato & Torretta, 2019:1; Hossain, Al-Hamadani & Rahman, 2015:3).

People working in e-waste enterprises generally collect or buy e-waste from households by means of an informal collection and recycling of electronic waste technique; this collection approach is common in underdeveloped nations (Baldé, Forti, Gray, Kuehr & Stegmann, 2017:32). Door to door, they collect and purchase e-waste before selling it to recyclers and re-furbishers (International Labour Organization, 2014:18; Shevchenko *et al.*, 2019:10). The recycling goal is dual purpose, namely to reduce the amount of electronic waste to be treated and to encourage the recovery of important metals (Rao, Singh, Morrison & Love, 2020:4300; Singh & Gautam, 2014:474). The reduction in adverse impacts in formal recycling is attributed to recycling processes taking place in a controlled setting. In a regulated environment, human health and the environment are prioritised. Workers in formal recycling, for example, use safety equipment. Formal recycling is costly and frequently employed in wealthy countries (Abalansa *et al.*, 2021:2; Ceballos & Dong, 2016:157; Grant *et al.*, 2013:351; Joon, Shahrawat & Kapahi, 2017:3). Systematic recycling has several benefits, such as providing jobs and a source of income, cutting manufacturing costs so that essential resources are easily accessible, and reducing health and safety hazards (Alias *et al.*, 2014:446; Nahman, 2010:7; Park *et al.*, 2017:2). Although it is desirable for e-waste to be recycled at authorised locations, research shows that the absence of financing for institutional recycling facilities, especially in developing countries, encourages illicit recycling (Abalansa *et al.*, 2021:2). Unauthorised reuse of e-waste is distinguished by personnel who have received little or no training; there is an absence of safety supplies, and hazardous techniques are used, such as acid baths, to remove or strip metals off components (Burns *et al.*, 2019:2). In India, about 400 000 families in the Moradabad district are working in the unofficial e-waste recycling industry (Corwin, 2018:78). Manual disassembly and recovery of precious materials, acid extraction of metals, shredding, melting, and extrusion of plastics, burning polymers and leftover materials, and toner sweeping are common procedures employed in unofficial recycling (Lundstedt & Swedish Environmental Protection Agency, 2011:1; Purchase, Abbasi, Bisschop, Chatterjee, Ekberg, Ermolin, Fedotov, Garelick, Isimekhai, Kandile, Lundström, Matharu, Miller, Pineda, Popoola, Retegan, Ruedel, Serpe, Sheva, Surati, Walsh, Wilson & Wong, 2020:1736).

Manual removal and regaining precious materials indicate that disassembly is done by hand with instruments, such as hammers and chisels, as well as bare hands. Melted solder is collected, and pliers are used to remove other important components attached to the motherboards. The chip-free boards are acid-treated to extract substances with monetary value (Orisakwe *et al.*, 2019:2). Finally, unused sludge and acid are generated into the biosphere (Hameed *et al.*, 2020:6). Incineration is preferable to open air as the reduced toxicity level would be acceptable to accommodate waste for dumping in landfill sites. Generated heat from incineration could be conserved as an energy source (Kim & Jeong, 2017:1; Singh & Gautam, 2014:475). Incineration is e-waste burning at high temperatures in incinerators, resulting in a significant reduction in waste volume (Gutberlet, Bramryd & Johansson, 2020:5). Inhaling smoke from fireplaces can induce asthma episodes as well as other warning signs, such as abdominal pain (Decharat & Kiddee, 2020:42; Tam, 2011:125). Leachate is a concern with landfilling (Vaverková, 2019:3). When rainwater penetrates garbage in a sanitary landfill, an enzyme reaction occurs, resulting in leachate (Koda, 2012:929). Landfilling should always be discouraged, since it does not diminish hazardous pollutants that are damaging to people and the surroundings. (Njoku, Edokpayi & Odiyo, 2019:1; Siddiqua, Hahladakis & Al-Attiya, 2022:58520). In this research, the sustainable disposal of e-waste created by IT equipment (Figure 2-3) is emphasised.

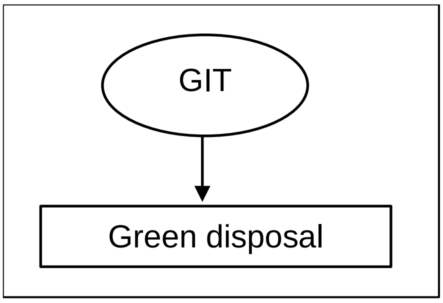


Figure 2-3: The emphasis of this study

In this research the focus is on the sustainable and effective disposal of obsolete IT equipment. IT equipment waste is a rapidly rising component of e-waste in organisations, such as HEIs, where there is little understanding of its negative consequences for the environment (Dayaday & Galleto, 2022:534; Iyer, 2014:98; Subhaprada & Kalyani, 2017:507). Because of their significance in educational activities, HEIs have become major generators of IT waste (Castro & Zermeño, 2020:1; Iyer, 2014:98; Zhang, Hao, Chen & Morse, 2020:2). Furthermore, the COVID-19 epidemic has compelled practically all HEIs to shift to online instructional methods (du Plessis, Jansen van Vuuren, Simons, Frantz, Roman & Andipatin, 2022:1; International Association of Universities

(IAU), 2020:11; Mthethwa & Luthuli, 2021:100). Higher education institutions will eventually exacerbate the increase in waste quantities due to the unprecedented requirements of electronic items (Turaga, Bhaskar, Sinha, Hinchliffe, Hemkhaus, Arora, Chatterjee, Khetriwal, Radulovic, Singhal & Sharma, 2019:127). Most of the research on GIT focuses on strategies to decrease energy consumption caused by IT equipment. Hence the study’s emphasis is on the green disposal of IT waste (Debnath *et al.*, 2016:669).

2.7 Summary

Each source was assessed critically throughout the chapter, along with comparisons and contrasts to other pertinent works on the subject. The consideration of the sources was incorporated into the chapter's argument concerning the current level of knowledge on the subject. Therefore, the following conclusions could be drawn:

Electronic waste is everyone’s problem. It does not discriminate along racial or regional lines. It is considered as one of the modern challenges facing humanity. The statistics tell the story of how rampant the problem of e-waste is. The factors that lead to proliferation of e-waste were discussed and identified. However, people are yet to be aware of its implications for human well-being and the environment. It was demonstrated how rich countries take advantage of the poorer or developing countries by sending their unwanted waste disguised as donations. It became evident how expensive it is to manage e-waste in an environmentally friendly way. Why developing countries are still mired under the mismanagement of electronic waste despite its unpleasant outcomes when handled improperly was also debated.

In the next chapter, there is a summary of previous research on green information technology, one of the study's key objectives. The goal of a literature review on green information technology is to gather information on the research and discussions that have been conducted that are pertinent to this study.

CHAPTER 3 GREEN INFORMATION TECHNOLOGY

3.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

In this chapter, the focus is on green information technology and how it affects today's society and organisations. Background information on green information technology and initiatives thereof are provided. An overview of the literature is discussed by highlighting some challenges associated with the implementation of green information technology.

Green information technology also referred to as green computing (Harjani & Gopalan, 2013:1; Nwankwo *et al.*, 2020:4378) advocates ways to minimise the negative environmental impact associated with the production and use of information technology equipment (Ara, 2018:43; Prasad, Murthy, Gireesh, Prasad & Sravani, 2021:34). It is both a field of study and a set of environmentally friendly practices on the use, design and manufacturing, and disposal of electronic waste (Ahmad & Nordin, 2014:64; Ramanujam & Napoleon, 2020:5972). The general population are often not knowledgeable on or aware of environmentally friendly practices associated with green information technology (Alias *et al.*, 2014:21; Kitila & Woldemikael, 2019:35). yet, it is imperative to embrace green information technology to counteract the effects of electronic waste.

A brief introduction to green information technology in relayed Section 3.2, followed by an investigation into the forces behind and problems of green information technology in Section 3.3. In Section 3.4, the Organisation for Economic Cooperation and Development, as well as a green information technology framework are discussed, while green information technology projects driven by global corporations are presented in Section 3.5. An outline of the expanded role of information technology producers is given in Section 3.6. A summary of the chapter appears in Section 3.7.

3.2 Green information technology overview

Green information technology (GIT) is a topic of research, as well as a set of ecologically responsible methods for electronic waste (e-waste) usage, design and production, and disposal (Ahmad & Nordin, 2014:64; Ramanujam & Napoleon, 2020:5972). Green computing is another term for GIT (Harjani & Gopalan, 2013:1; Nwankwo et al., 2020:4378). The general public frequently lacks knowledge and understanding of ecologically beneficial actions (Alias et al., 2014:21; Kitila & Woldemikael, 2019:35). To combat the impacts of electronic waste, however, it is crucial to adopt GIT.

Green design, production, usage, disposal, standards and metrics, including strategies and policies of GIT are the six complimentary orientations that make up a holistic approach to GIT (Bokolo, 2020:2; Murugesan, 2008:8). By focusing on these, information technology (IT) equipment might be made environmentally friendly over its full life cycle (Murugesan & Gangadharan, 2012:8; Nwankwo *et al.*, 2020:4378). While green standards and metrics relate to promoting, contrasting, and measuring sustainability activities, goods, services, and practices, GIT strategies and policies explain practical and successful business plans and policies (Buonocore, Choma, Villavicencio, Spengler, Koehler, Evans, Lelieveld, Klop & Sanchez-Pina, 2019:2; Megwai, Njie & Richards, 2017:341). Green production is the development of items with the intention of not posing a threat to the environment once they have reached the end of their useful life (Jaiswala *et al.*, 2015:1323; Tamanna & Iqbal, 2020:46). The creation of components using a technique that gradually lowers non-value-added resources is known as green design in contrast (Jaiswala *et al.*, 2015:1323; Tamanna & Iqbal, 2020:46). Green usage involves making IT resources, such as computers, information systems, and other ancillary subsystems, more effective while sparingly utilising energy (El-Mawla & Ibrahim, 2022:1; Goyal & Garg, 2022:54; Shuja, Ahmad, Gani, Abdalla Ahmed, Siddiqa, Nisar, Khan & Zomaya, 2017:2). Environmentally friendly disposal methods are referred to as green disposal (Ramanujam & Napoleon, 2020:5972; Salles, Lunardi & Thompson, 2022:3). Figure 3-1 depicts GIT’s complementing directions.

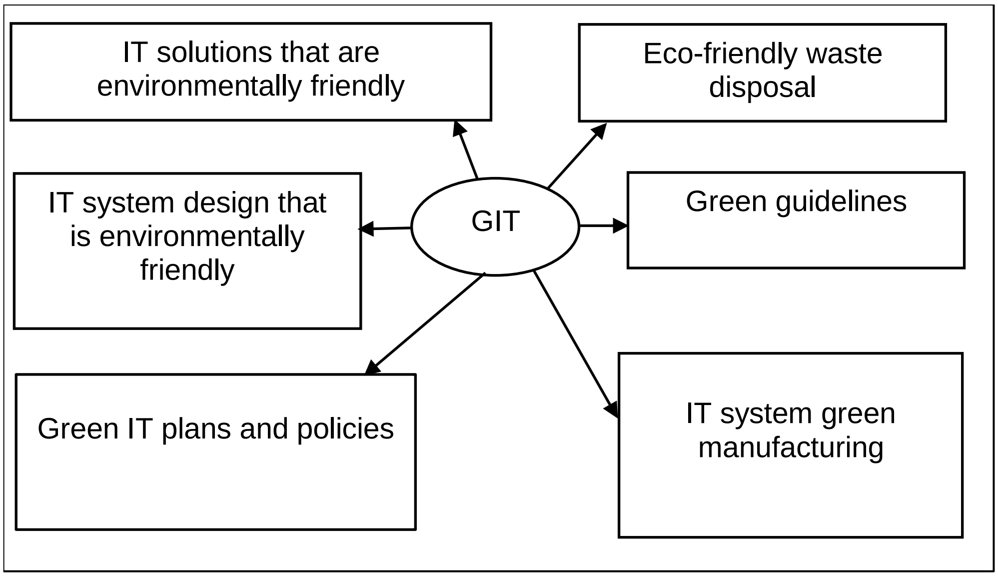


Figure 3-1: A multifaceted, holistic approach (Murugesan, 2008:27)

The three categories of green design and manufacture, green usage, and green disposal are used to manage the environmental effect of information technology (Murugesan, 2008:27; Tamanna & Iqbal, 2020:46). Figure 3-2 below illustrates these categories.

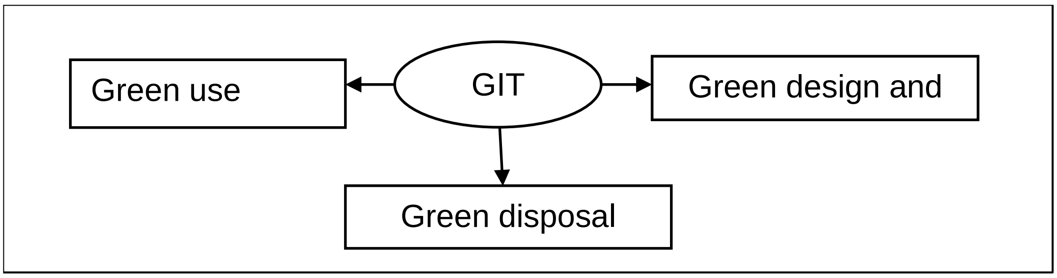


Figure 3-2: Information technology's environmental aspects (Tamanna & Iqbal, 2020:46)

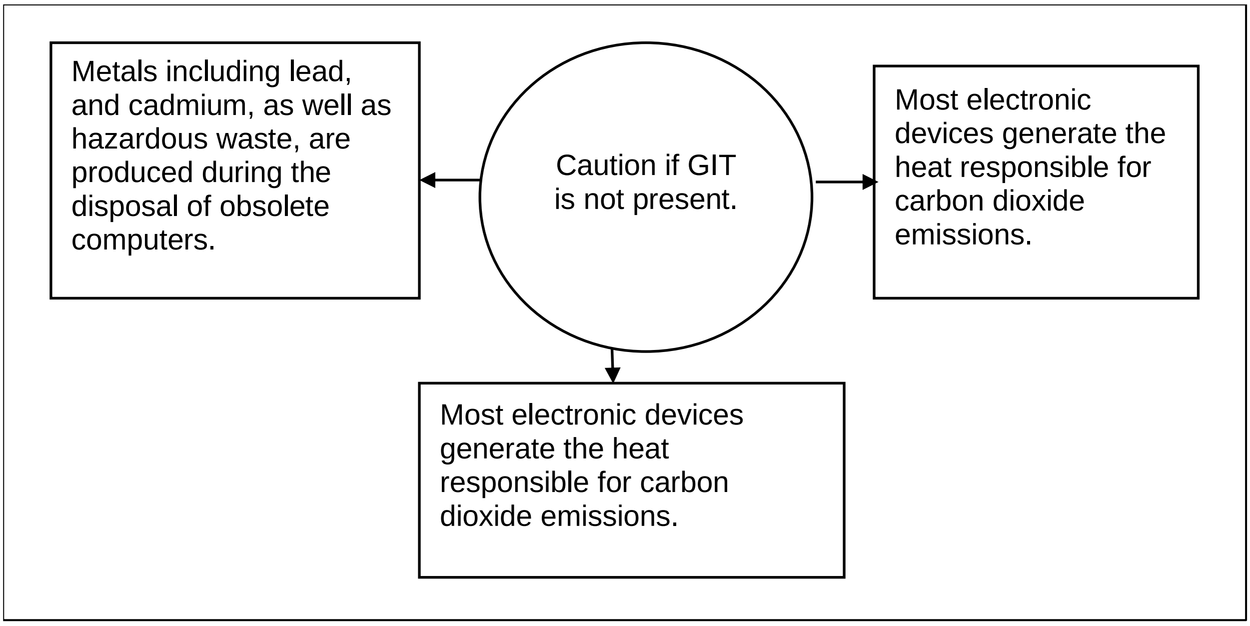


Figure 3-3 illustrates the consequences on health and the environment of not using GIT practices.

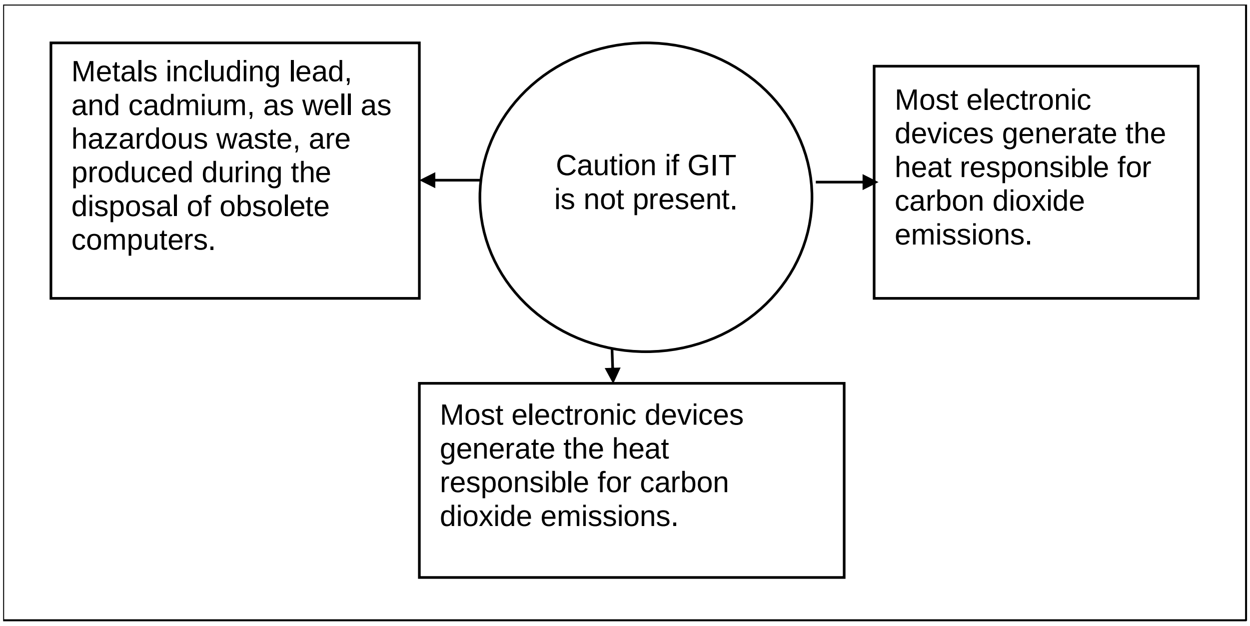


Figure 3-3: Effects of not using green information technology (Naim, 2021a:37)

3.2.1 Design and production

Over 50% of all energy is lost due to inefficient technology and poorly planned systems (Anwar, Ghaffar, Razzaq & Bibi, 2018:2; Bharany, Sharma, Khalaf, Abdulsahib, Al Humaimeedy, Aldhyani, Maashi & Alkahtani, 2022:2). Chemicals, water, and various other raw materials are consumed during the production of IT equipment, and hazardous waste is created (Oláh, Aburumman , Popp , Khan, Haddad & Kitukutha, 2020:1). Low raw material costs, increased production effectiveness, decreased environmental and occupational safety costs, and enhanced brand perception can all result from green manufacturing (Biswajit, 2018:467; Sezen & Çankaya, 2013:161). The usage of bio-products and environmentally friendly designs are the key points of emphasis. Eco-friendly designs are computer resources that are Energy Star compliant. When not in use, energy-efficient designs switch to a low-energy saving mode (Environmental Progress Report & Jackson, 2022:18; Singh & Vatta, 2016:281). Table 3-1 presents some of the literature-identified hurdles to green manufacturing (Abubakr, Abbas, Tomaz, Soliman, Luqman & Hegab, 2020:5; Chiet, Ching, Saw Lip, Fathi & Tzuu, 2019:3; Mittal & Sangwan, 2014:560).

Table 3-1: Green manufacturing barriers and descriptions (Plooy, Neethling, Nel & Nel, 2022:15)

Description	Issue
Inadequate measures	Environmental laws are absent; laws are ineffective and/or confusing.
Insufficient enforcement	Laws that are not effectively enforced or that are not enforced at all; corruption; and insufficient monitoring systems.
Low levels of public pressure	Local communities, the media, non-governmental organisations, and politicians have all failed to exert meaningful pressure.
Short-term expenses are high	Higher start-up and implementation expenses
Future legislation is unknown	Immature legislative developments; the prospect of wholly new regulations in the future
Benefits that are not certain	Uncertain and/or negligible economic gain; poor rate of return on investment; earlier repayment of previous investments
Customer demand is low	Customers who are price sensitive; a desire for cheaper items; and a lack of environmental awareness in the market
The compromises	Environmental issues are outsourced to other nations with lax environmental regulations, and product life cycles are short
Low commitment from senior management	For senior management, environmental problems are not a concern.
A scarcity of organisational resources	Lacking access to financial resources or money, as well as a lack of professional or trained labour
Risks associated with technology	Implementing more advanced or complicated technology might be risky; doing so could cause trouble, and it might also conflict with current systems.
Ignorance or lack of knowledge	Inadequate knowledge of green trends, limited availability of environmental literature

Some of the problems of green design include limited research in this field, funding limits, a shortage of trained designer criteria that a green product must meet (Glantschnig, 1994:75; Zuniga-Teran, Staddon, de Vito, Gerlak, Ward, Schoeman, Hart & Booth, 2020:710).

3.2.2 Equipment usage

According to Patil and Kharade (2016:11142), only 15% of the USD 250 billion annually spent on energy consumption by IT equipment is used for computation; the remainder is lost to inactivity. The second largest source of energy consumption in data centres is cooling, with the first being data centre operation. A typical data centre requires 1 megawatt of power, costs USD 20 million to run over its lifetime, and accounts for 30%-40% of that cost in cooling systems. An extremely expensive system will cost as much to run and cool as new hardware will cost in two years (Bharany *et al.*, 2022:2).

Currently, we face global warming and significant biosphere threats because of increased carbon dioxide (CO2) emissions and energy use, which has had a disastrous effect on our ecosystem. Massive amounts of energy are used by data centres, computing devices, network equipment, etc., which is mostly produced by thermal power plants (Bharany *et al.*, 2022:1). An estimated 4% to 6% of the world's electricity consumption in 2020 was attributed to IT equipment, including data centres, communication networks, and consumer devices. Over the next ten years, there will likely be a rise in the global usage of IT energy due to rising demand for IT hardware. The technology's continual advancements in energy efficiency have been acknowledged by experts. The energy consumption of IT equipment, however, is little documented, and estimates at this time are highly uncertain (United Kingdom Parliament Post, 2022:1). According to the estimate, under the worst-case scenario, IT equipment might consume up to 51% of all electricity worldwide in 2030 (Andrae & Edler, 2015:117). This will occur if it is not able to increase the electricity efficiency of fixed access networks and data centres, as well as wireless access networks sufficiently. Virtualised or cloud data centres are data centres that use virtualisation to reduce energy usage (Ahmad, Maroof, McClean, Charles & Parr, 2020:613; Bari, Boutaba, Esteves, Granville, Podlesny, Rabbani, Zhang & Zhani, 2013:910). Virtualisation enables the simultaneous use of many operating systems on a single hardware platform while maintaining the highest system performance (Ali & Meghanathan, 2011:1; Balen, Vdovjak & Martinović, 2020:426).

The National Institute of Standards and Technology define cloud computing as:

> *"a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources such as networks, servers, storage, applications and services that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Saini, Kumar & Gupta, 2022:1).*

Data processing and storage are supplied as services in a cloud computing environment (Makela & Luukkainen, 2013:75; Mesbahi, Rahmani & Hosseinzadeh, 2018:2). Efficiency, or the automated on and off switching of resources, determines how much energy is consumed (Attaran, 2017:2; Makela & Luukkainen, 2013:75). The demand for cloud computing environment services has lately prompted concerns about power usage that results in an increased carbon footprint, in addition to the benefits that cloud computing delivers (Pazowski, 2015:1859; Wahlroos, Pärssinen, Rinne, Syri & Manner, 2018:1749). Efficient data centres with high levels of utilisation will not solve the issue of carbon dioxide emissions; they will just make it worse (Srimathi, Hemalatha & Balachander, 2012:168; Wahlroos *et al.*, 2018:1749). The energy required to cool down the resources, however, also adds to the carbon imprint (Avgerinou, Bertoldi & Castellazzi, 2017:1; Srimathi *et al.*, 2012:169). According to El-Mawla and Ibrahim (2022:1), the issues with standard cloud computing, such as power usage and carbon impact, may be solved by GIT techniques, such as green cloud computing. The term green is derived from the phrase green cloud computing which refers to environmentally friendly methods (Harjani & Gopalan, 2013:1).

3.2.3 Equipment disposal

Long-term usage minimises the amount of electronic waste that may otherwise harm human health or the environment. The life cycle of information technology equipment, for example, may be extended by reconditioning and replacing parts. The market for refurbished IT parts is growing (Esmaeilian, Saminathan, Cade & Behdad, 2021:1). The production of a new personal computer produces more carbon dioxide than modernising an existing one (André, Ljunggren Söderman & Nordelöf, 2019:268; Appasami & Suresh, 2011:42). By swapping out faulty components, refurbishment changes outdated or malfunctioning items (Reike, Vermeulen & Witjes, 2018:256). Green information technology and sustainability are related. Green information technology is committed to improving system performance and usability while upholding its social and ethical obligations. Consequently, the dimension of environmental sustainability is included in GIT (Abualfaraa, Salonitis, Al-Ashaab & Ala'raj, 2020:2; Naim, 2021a:13). Environmental sustainability refers to human, social and economic advancement that benefits generations of today and tomorrow without having any adverse consequences on the environment or natural resources (Guemes & Herrera, 2016:21). The ability to conduct business and innovate without endangering the environment, ecological health, or human health is what makes environmental sustainability so crucial (Dogaru, 2013:1344; Sadiku, Ampah & Musa, 2018:248).

In order to successfully incorporate green initiatives and strategies into their business operations, IT-based organisations must take into account society, economies and the biosphere (Bokolo, 2016:51). The triple bottom line, sometimes referred to as People, Planet, and Profit (3Ps) paradigm for accounting, emphasises a dynamic assessment of society, the environment, and profit as aspects for gauging the success of organisations or businesses (Bokolo, 2016:55; Schulz & Flanigan, 2016:449). Employees, consumers, and local communities are all included in the 3Ps framework's people category (Abualfaraa *et al.*, 2020:1; Fauzi, Svensson & Rahman, 2010:3). The biological environment in which the business operates is referred to as plane*t* (de Ridder, 2007:423; Kumar & Bhaskar, 2016:6). The method by which all costs associated with producing various goods are removed from total revenues to determine the amount of money a business keeps as return on its capital investments is known as the profit (Arowoshegbe, Emmanuel & Gina, 2016:104; Spicer, 2013:1). In the third column, each triple bottom line model dimension is associated with a set of goals that an IT organisation should seek to fulfill. It should also be noted that all sustainability objectives are equally important (Bokolo, 2016:55). Table 3-2 depicts three Ps sustainability.

Table 3-2: Organisational sustainability objectives (Bokolo, 2016:53)

Target	Three bottom lines	Focus
Profit	**The financial benefits**	Considering finances: This is the sum of money that the management is willing to invest on procedures of GIT. Money saved: Most operations that will result in accomplishing the goals of sourcing at a cost less than the starting cost are of relevance to IT-based organisations.. Monetary gain: IT-based businesses will be encouraged to adopt sustainable practices if there is a financial return, particularly, the difference between the total generated from organising green activities and the sum spent on managing, purchasing, or installing these green initiatives and systems.. Stimulus: An additional incentive for IT specialists and practitioners Low spending plan: A financial objective known as the minimal cost pricing method might influence IT-based organisations to use sustainable practices
Plane t	**The surroundin g ecosystem**	Unsustainable use of resources that are natural: Resources on earth are limited and not replenishable. These limited resources must be preserved by humans or they will all run out. Production of waste from electronics: Electronic waste generation is deemed damaging to the environment, livestock, and people. Electronic waste should be disposed of in an environmentally responsible way to reduce or eliminate its harmful impact on the environment and health. Reducing water usage: Another strategy to alleviate global water scarcity is to reduce water consumption in IT-based organisations. Soil biodiversity conservation: Many nations are taking steps to reverse soil deterioration. A healthy soil is beneficial to all living things. All living animals will ultimately become extinct as a result of soil degradation..
Peopl e	**Society as a whole**	Mimetic forces*:* the act of copying another's organisational style with the belief that it will be advantageous. This behaviour is carried out without regard for the latter business setting. This pressure will most probably have an impact on organisations' readiness to participate in green efforts. Normative forces: A pressure that exists within an organisation is normative pressure. The pressure is caused by the exchange of best practices among experts and practitioners from various firms or enterprises. Coercive forces: Organisations are subject to coercive pressure from government and industry laws, which strongly promote the spread of GIT.. Regulatory market: Because demand and supply are governed by the government in this situation, market forces or powers may have an impact on organisations that practice environmental consciousness.

It is possible to make a computer ecologically friendly throughout its entire life cycle, minimising its carbon footprint. It is also feasible to stop dangerous components from being discharged into the environment or the open air when a computer is disassembled. IT subsystems and their peripherals may all be greened. Small adjustments in how these devices are utilised can drastically cut energy use. Furthermore, replacing harmful metals in components with greener ones might help to make IT equipment greener. Figure 3-4 depicts the greening of the life cycle of a computer.

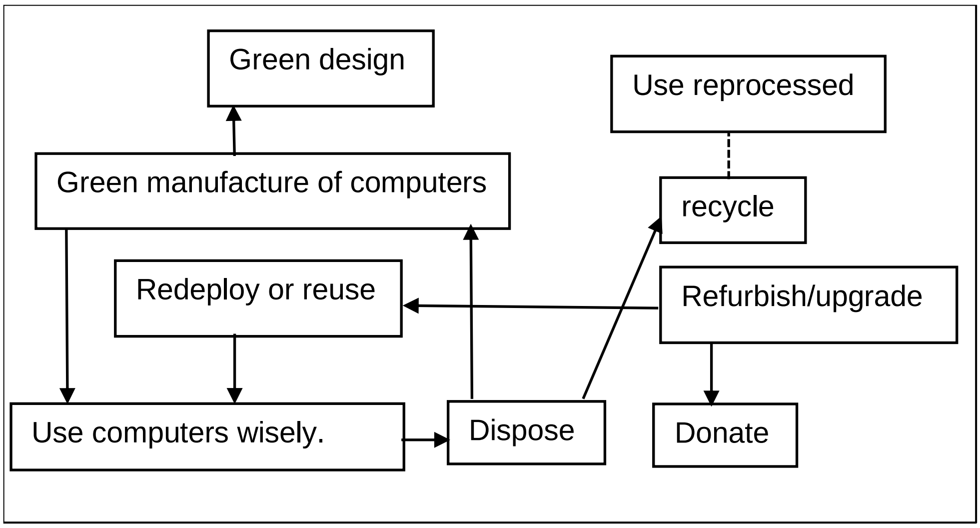


Figure 3-4: Green computer's life cycle (Bokolo, 2020:6)

3.3 Drivers and challenges

Statistics on the environment, energy use, e-waste, and rising costs are the motivating factors behind green information. Environmental data show that, while the carbon footprint created by the IT business is substantially lower than that of other sectors, it is nonetheless a source of worry, owing to its environmental effect. Information technology share of global greenhouse gases is estimated between 2.1% and 3.9% (Freitag, Berners-Lee, Widdicks, Knowles, Blair & Friday, 2021:1). Initiatives and methods related to GIT have been demonstrated in the literature to have the ability to lessen atmospheric greenhouse gas build-up. Consumers of IT goods are concerned about energy usage in the form of, say, electricity. GIT policies and activities must be developed in order to minimise energy consumption on existing and future facilities (Attaran, 2017:2). Increased cost is the term used to describe rising expenses associated with the organisation's failure to adopt GIT measures, such as energy prices. The rapid proliferation of data centres has dramatically raised an organisation's energy bills (Zhang, Lindberg, Xiong, Vyatkin & Mousavi, 2017:2048). Reduced environmental harm and enhanced human health are the direct advantages of GIT. A comprehensive approach to GIT projects and strategies can provide additional advantages at the micro (individuals and families), macro (nations or countries), and mezzo (industries, companies, and organisations) levels. When businesses use GIT, they will be better able to fulfil their social obligations, enhance their brand perceptions, and repair their reputations (Bokolo, 2016:53; Chmielarz, 2017:22; Peng, 2013:10). Figure 3-5 highlights further advantages of implementing GIT strategies.

The societal advantages of green information technology • Carbon emission reduction • Less energy and natural resources are used. • Assist populations in meeting their pledge to reduce the impact of carbon dioxide. • A country's or nation's image is improved.
Green information technology's advantages for businesses and organisations • Energy costs are lowered. • A more effective use is made of the IT infrastructure • Increase the lifespan of hardware • Increase satisfaction among staff members and loyalty • Fulfilment of social responsibility • Marketing attempts significantly improved • Enhance the business reputation and image

Figure 3-5: Sustainability of green information technology (Masood & Alam, 2019:652)

Organisations are encouraged to pursue GIT for a variety of reasons (Dedrick, 2010:176; Hankel, Heimeriks & Lago, 2019:1); outlines the reasons why organisations might use GIT. Table 3-3 outlines the reasons why organisations might use GIT.

Table 3-3: Benefits of green information technology for businesses (Hankel *et al.*, 2019:1)

Percentage of organisations agreeing / Why should you use GIT?	Organisations agreeing as a percentage (%)
Information technology cost reduction	80
Business strategy	79
Consideration for the Environment	77
Acceptance in society	71
Green information technology industry maturity	64
Government rules and regulations	57
Client/consumer pressure	48
More organisations are using GIT	46
Associations of business	29
The activities of competitors	20
IT suppliers exert pressure	14

Most companies view the GIT market as untapped, and they use their patent and other intellectual property rights to technologies to try to get market share. Banks even make it easier for firms to borrow money provided they demonstrate a commitment to operating in an ecologically responsible manner. When organisations try to implement green initiatives, they confront several hurdles. These include, for instance, a lack of resources, an absence of organisational structure, ambiguous goals and objectives, and a lack of knowledge and expertise to carry out GIT initiatives (Hankel *et al.*, 2019:2). Environmental, financial, organisational, technology, awareness, and commercial opportunity variables are some of the elements that influence the adoption of GIT in institutions or organisations (Ramli, Chew & Saptari, 2021:1431). Green information technology can be costly for small to medium business contrary to big or older companies, as the larger companies have financial backing and are efficient in introducing innovation processes (Demirel, Li, Rentocchini & Tamvada, 2019:761; Soni, 2015:1).

Green information technology's high implementation costs frequently require the use of non-green technologies (Knobloch & Mercure, 2016:39; Wabwoba, Wanyembi & Omuterema, 2012:825). When acquiring GIT equipment, the following factors must be examined, among others: hardware, software, network, and recurring expenditures. When confronted with a limited budget, organisations may choose to accept donations or reconditioned gadgets. Unfortunately, most of these donated and repaired components are junk or true e-waste (Wabwoba *et al.*, 2012:825; Wang *et al.*, 2020:2). Due to a lack of understanding, organisations frequently miss out on chances that are provided to them. This also results in missed opportunities for the adoption and implementation of GIT. Many people would like to use GIT if they understood what it was and how to utilise it (Ogunyemi & Johnston, 2012:105; Okewu *et al.*, 2017:2). Information technology employees are at the forefront of green information technology. When it comes to duties and activities, those who are educated about them instinctively dedicate themselves. Awareness has been found to affect perceptions of the utility and usability of technologies, according to models and theories in IT research (Masele, 2019:211; Wabwoba, Wanyembi, Omuterema & Mutua, 2013:95). Knowledge gaps, practice gaps, knowing-doing gaps, and opportunity gaps are all notions that inhibit GIT (Esfahani, Shahbazi, Nilashi & Samad, 2018:12; Jenkin, Webster & McShane, 2011:266). Table 3-4 provides important instances.

Table 3-4: Gaps in green information technology (Esfahani *et al.*, 2018:12)

Type of gap	A description	Exemplary instances
A gap in knowledge	The extent to which employees are aware of internal organisational activities varies.	The organisation supports and gradually implements video conferencing. Employees, however, are unaware of this behaviour.
A gap in practice	Organisations are not accomplishing what they claim to be doing.	Organisations claim to encourage the reuse and recycling of outdated IT equipment. However, management did not inform employees about these actual procedures.
A gap in opportunity	Employees are aware of internal organisational events and spot possibilities where the company might profit. It is not implemented.	Organisational proponents claim that they are attempting to reduce the consumption of printing materials. Employees offer more effective techniques to minimise printer paper usage. The solution has not been applied.
A gap in Knowing doing	The staff members are aware of a problem and believe a solution is worthwhile, but they do not alter their behaviour to reflect the notion.	As for staff, it would be advantageous to reduce energy use, turn off devices when not in use, especially at night. and associated costs. Employees, on the other hand, do not alter their behaviour as a result.

Organisations that implement and embrace GIT frequently overlook the need of informing their stakeholders. Employees, clients, suppliers, and users must be made aware of the organisation's attitude on GIT and IT related environmental concerns (Zaman & Sedera, 2015:8). Literature has identified the following as barriers for HEIs to implement GIT, namely high adoption cost, lack of environmental knowledge and GIT awareness, lack of trust, adoption scepticism, institution adoption rate and switching barrier issues, resistance to change, and lack of communication (Chin Lay, Ahmad & Huey Ming, 2013:23; Gholami, Bachok, Saman, Streimikiene, Sharif & Zakuan, 2020:1). Green information technology can appear to be complex and time consuming and is therefore often not attempted (Iravani, Akbari & Zohoori, 2017:282; James & Hopkinson, 2009:70). To provide a high-quality service, the necessary qualities and abilities must also be present (Radu, 2016:1; Wabwoba *et al.*, 2012:825). Rather than equipment or technology, quality service is the result of trained and qualified employees. As a result, organisations must retrain people or pay for expensive outsourced talents in order to use GIT properly (Demirel *et al.*, 2019:761). The four key values in respect of pro-environmental behaviour are as follows: biosphere values: caring about the environment and nature, altruistic values: motivate individuals to invest in the well-being of others or the community, egoistic values: safeguarding and promoting personal resources or achievements, and hedonic values: relate to pleasure derived or experienced from the behaviour.

3.4 Organisation for Economic Co-operation and Development

The GIT framework with three layers of analysis: systemic impacts, enabling impacts, and direct impacts of IT, was presented by the Organisation for Economic Co-operation and Development (OECD) (Naim, 2021a:15; Radu, 2018:29). Information technology's first-order effects on the environment are known as its direct impacts. They cover both adverse and advantageous outcomes brought on by IT products, services, and associated procedures (Bokolo, 2020:3). The whole life cycle of these objects' processes are sources of IT tools that have a direct influence on the environment. The second-order benefits of IT applications that lessen the environmental repercussions of various socioeconomic activities are known as enabling effects (Esfahani *et al.*, 2018:8). Third-order effects are the systemic implications of IT. They include non-technological elements, like a shift in attitudes concerning the effects of using IT equipment on the environment and other non-technological aspects (Bokolo, 2020:3). The framework is depicted in Figure 3-6 below.

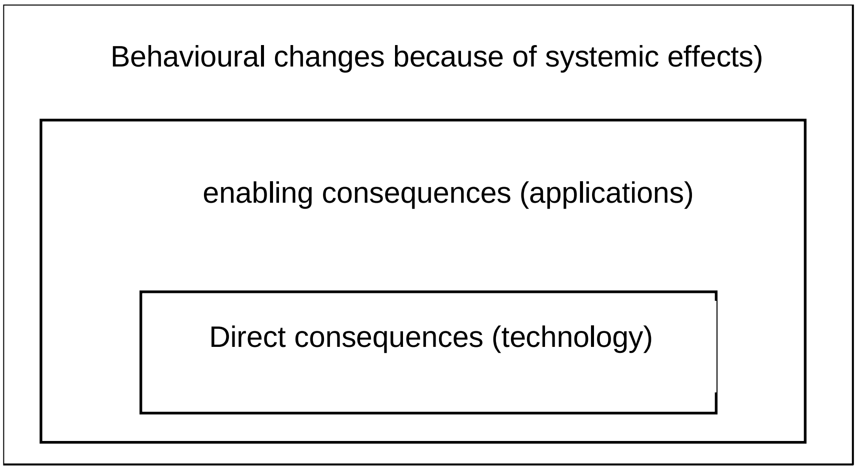


Figure 3-6: Proposed green information technology framework (Radu, 2018:29)

3.5 Green information technology initiatives

Due to the adverse environmental effects of e-waste brought on by the unprecedented rise of IT goods, small to medium-sized businesses have undertaken IT initiatives and solutions, as indicated in Table 3-5.

Table 3-5: Green information technology solutions and projects (Rane, 2022:15)

Initiatives / Solutions	Eco-friendly waste disposal	Sustainable design and production	Eco-friendly practices
	Recycling of computer equipment	Cloud computing	Consolidation and virtualisation Computing on mobile devices Less travel Paper conservation

Investments in GIT projects have already been made by several international organisations. In contrast, large enterprises have financial backing and are efficient at introducing innovation processes (Demirel *et al.*, 2019:176). Several significant corporations participating in GIT initiatives will be addressed.

3.5.1 International Business Machines

International Business Machines is a multinational IT company that is based in the United States of America (USA) with operations in over 170 countries around the world. The company's business is hardware, software, and network facilities. Green information technology received a United States Dollar (USD) one billion investment from International Business Machines (IBM) in 2007. The funds were utilised to build more energy-efficient data centres (IBM, 2007:1).

International Business Machines has developed a program in China (Beijing) to predict pollution episodes with between 48 and 72 hours' prior warning on a scale of a square kilometre (Sajhau, 2017:56). It is estimated that cloud computing uses 73% less energy than companies without this technology (Bokolo, 2016:58). On their web site, Big Blue promises to:

> *"use development and manufacturing processes that do not adversely affect the environment, including developing and improving operations and technologies to minimise waste, prevent air, water, and other pollution, minimise health and safety risks, and dispose of waste safely and responsibly"(Naim, 2021b:47).*

When it comes to its environmental strategy, the corporation is highly transparent about its successes and shortcomings, for instance outlining its handling of hazardous waste (Naim, 2021b:47).

3.5.2 Digital Electronic Link Library

Computer hardware and software are the focus of the global business, Digital Electronic Link Library (DELL) (Bokolo, 2016:58). Regarding carbon footprints digital electronic link library introduced the Zero Carbon strategy initiative. DELL's attitude is connected to its product's life cycle, which includes design, construction, shipping, functioning, and recycling operations (Hema, Subhashini & Lakshmi, 2017:55; Nuttapon & Gabriel, 2012:20). When it comes to packaging and recycling, the corporation has been a leader in the IT industry. The corporation has outlined goals for the plan, including a reduction of greenhouse gas emissions from its facilities and logistical operations, as well as an 80% reduction in the energy intensity of its product line. Digital electronic link library, one of the biggest manufacturers of laptops and monitors, is also included on this list, since it strives to improve the environment by sourcing its electrical needs from renewable sources of energy. To become self-sufficient in energy, the corporation has made significant investments in solar and wind power (Naim, 2021b:46).

3.5.3 Intel integrated and electronics and Hewlett Packard

Manufacturers of desktop personal computers and printers include Hewlett Packard (HP) (Bokolo, 2016:59). Nearly 30 years ago, HP began making efforts to lessen the damaging effects that its products have on the environment. Efficiency of energy in information centres, ecological systems, visual collaboration, and environmentally friendly structures are just a few examples of HP's green business practices. The company uses green energy to power around 20% of its technology and services, enabling customers all over the world to improve their IT productivity. Additionally, the corporation recently set a goal to source 100% clean energy in the long run and more than 40% of its total energy usage from clean energy sources by 2020 (Naim, 2021b:47).

A worldwide business called Integrated and Electronics (Intel) makes processors, chips, network interface controllers, and other computer parts (Bokolo, 2016:59). Intel integrated and electronics has embraced green strategies and efforts, such as the use of virtualisation, energy-efficient services, and solar panel installations (Grant & Marshburn, 2014:7; Żygadło, Kotowski & Oko, 2018:1). Intel integrated and electronics leads the way in consuming up to 3,100,000,000 kelvins of green energy. The green energy used by Intel, which includes 18 on-site solar panels with a 7 000-kilowatt capacity, comes from sources, such as wind, solar, hydro, and biomass. The GIT is used by Intel to meet its electric operational needs for the production and processing of processors, as well as other computer peripherals. In order to run entirely on green energy, the company plans to keep growing and developing more renewable energy sources (Naim, 2021b:46).

3.5.4 Nokia and Toshiba

Known for selling electronic equipment, Toshiba is a worldwide corporation (Thongplew, Spaargaren & van Koppen, 2017:17). The company's objective is to strive to become a prominent environmental firm (Bokolo, 2016:59). Toshiba aims at lessening or reducing its impact on the environment. The three green initiatives that Toshiba has launched to help it reach its GIT goals are environmentally conscious technology, processes, and products (Nuttapon & Gabriel, 2012:20; Thongplew *et al.*, 2017:17). As one of the leading mobile phone manufacturers, Nokia developed a computer managed maintenance system (Chen, Chen, Li, Wang, Chen & Xu, 2018:2). The system's goal is to assist in saving water and natural resources utilised in manufacturing operations (Daphne & Anol, 2014:1). Nokia's utilisation of solar energy is yet another environmentally friendly method (Ahmed, Naeem & Iqbal, 2017:52). A solar panel integrated into the phone's back cover can be utilised to power mobile devices (Bokolo, 2016:59).

3.5.5 Systems Applications and United Parcel Services

Systems Applications and Products in Data Processing (SAP) is a global corporation established in Germany that provides software services to businesses to help them manage their business processes (AlMuhayfith & Shait, 2020:8; Pohlisch, 2020:6). Systems Applications and Products in Data Processing has taken many actions, including creating an application called the Recycling Administration System Application (Bokolo, 2016:59). Businesses may manage their recycling efforts using the program, cutting down on expenses and dangers associated with the environment. Additionally, by lowering related risks and expenses, the program aids businesses in adhering to environmental guidelines and legislation (Grant & Marshburn, 2014:2). Operating globally, United Parcel Services (UPS) delivers packages to both consumers and businesses. It is now challenging for UPS to transition away from fossil fuels due to the company's fleet size of roughly 88 000 vehicles, which includes aeroplanes (Bokolo, 2016:59). To cut carbon dioxide emissions, the corporation has made a large investment in information technologies. Data mining by the telematics system reveals patterns in logistics, vehicle upkeep, and fuel efficiency. The firm said that by adopting the telematics system, it was able to save each driver a yearly average of USD 188 units on fuel. As a result, carbon footprints are significantly reduced (Bokolo, 2016:58).

3.6 Extended producer responsibility

Extended producer responsibility is defined 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…it is a strategy designed to promote the integration of environmental costs associated with goods throughout their life cycles into the market price of the products" (OECD, 2001:28; Rau, Bisnar & Velasco, 2020:2).*

Extended producer responsibility (EPR) is a method of implementing environmental policy whereby a producer's accountability for a product extends through the post-consumer phase of the product life cycle. This marketing tactic aims to encourage the inclusion of environmental costs related to items prices until their "*grave*" (Rau *et al.*, 2020). Extended producer responsibility promotes the development of environmentally friendly products (Cheng, Lin, Wen & Chang, 2019:6; Ferrão, Ribeiro & Silva, 2008:1). A step toward removing governments and taxpayers from bearing the financial and material responsibility for the producer's goods is represented by EPR (Herdiana, Pratikto & Fuad, 2014:873; Rau *et al.*, 2020:1). Producers are expected to create products with the environment in mind as part of EPR (Hanisch, 2000:170; Mihai, Gnoni, Meidiana, Ezeah & Elia, 2019:9). The aspects that follow are examples of EPR: (i) extension of the life of the product, (ii) program called incentives of take-back, (iii) facilitation of upgrades through modular design, (iv) both recycling and disassembly, and (v) material utilised replacement (Shevchenko *et al.*, 2019:3).

Lindhqvist (2000:38) created a framework that describes EPR implementation models. Table 3-6 provides an explanation of these five extended producer responsibility models.

Table 3-6: Extended producer responsibility models (Lindhqvist, 2000:38)

EPR scheme / Scope	Description
Initial accountability	Information regarding the product and its effects on the environment must be made public by the producers. This obligation is supported by the producer's good faith and by legal restrictions.
Physical obligation	According to this obligation, the producer is in charge of the physical treatment and administration of the rejected or undesired good.
Financial accountability	This phrase refers to the obligation of the producer to bear the financial burden of managing the product that has been abandoned or used up in part or in whole.
The liability	The manufacturer is nonetheless liable for any harm the product causes over its entire lifespan.
The owner's obligation	All the obligations listed above are interconnected under owner responsibility. When the manufacturer keeps up its claim to legal ownership of the product, this obligation becomes applicable. The owner accountability model uses leasing as an example.

3.7 Summary

Throughout the chapter, each source underwent a rigorous evaluation, along with similarities and contrasts to related works. The state of knowledge on the topic included a study of the sources.

The conclusions that were drawn; green information technology is not a panacea, but rather a hope to salvage what is left and reduce further degradation of the environment because of electronic waste mismanagement. In this chapter, we learnt that green design, production, usage, disposal, standards, and metrics, including strategies and policies of GIT are the six complimentary orientations that make up a holistic approach to GIT. By reducing the use of dangerous components, GIT strives to increase energy efficiency, improve product biodegradability, and promote recycling. This process takes place from the inception of the product until it has reached its end-of-life stage. The challenges for GIT implementation were identified. The most pressing issue was the initial investment in GIT strategies. However, over time, the benefits far outweigh the initial costs.

In the next chapter, there is a summary of previous research on digital storytelling, one of the study's key aims. The goal of a literature review on green information technology is to gather information on the research and discussions that have been conducted that are pertinent to this study.

CHAPTER 4 DIGITAL STORYTELLING

4.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

Digital storytelling has been found to have the potential to raise and create awareness in different environments, such as cybersecurity, and other social issues, including health (Maragh-Bass *et al.*, 2022:2). In this chapter, there is a discussion on how digital storytelling may help people feel more empowered.

The literature on digital storytelling is reviewed. It starts with the discussion on what digital storytelling is and how it differs from traditional storytelling. How can empowerment be attained using digital storytelling? Several approaches to digital storytelling, e.g., multimedia, and transmedia narratives are highlighted. A discussion on different contexts where digital storytelling is applied, e.g., in education and museums is included. From the beginning of time, storytelling has been utilised to share knowledge, values, and wisdom (D'Abate & Alpert, 2017:4; Delgado-Ballester & Fernández-Sabiote, 2016:117; Hausknecht, Freeman, Martin, Nash & Kelly, 2021:286; Soule & Wilson, 2002:1). Humans and storytelling are inseparable entities, even in modern times. Nowadays, stories are told in ways that are easier and improved, information technology provides for unlimited possibilities in ways of telling a story (de Jager , Fogarty , Tewson & Lenette, 2017:2549; LaFrance & Blizzard, 2013:27; Shemy, 2020:802). Digital storytelling started to become a practice in the late 1990's and is considered an emerging area (Mirza, 2020:84; Rebmann, 2010:30).

In Section 4.2, narrative and digital storytelling are introduced, followed by Section 4.3 by the presentation of digital storytelling for empowerment. In Section 4.4, the difficulties in creating a narrative that is digital is presented. In Section 4.5 frameworks of digital storytelling are discussed. The comparison of digital storytelling and other knowledge-sharing techniques are provided in Section 4.6. In Section 4.7, several digital storytelling strategies are highlighted. Digital storytelling models that are both nonlinear, as well as linear are described in Section 4.8. The application of digital storytelling in various contexts is covered in Section 4.9. In Section 4.10, a summary wraps up this chapter.

4.2 Digital narrative and storytelling

Storytelling has been used to transmit information, values, and wisdom since the dawn of time (D'Abate & Alpert, 2017:4; Delgado-Ballester & Fernández-Sabiote, 2016:117; Hausknecht *et al.*, 2021:286; Soule & Wilson, 2002:1). Stories are now communicated in easier and better ways because of information technology, which offers countless options for communication (de Jager *et al.*, 2017:2549; LaFrance & Blizzard, 2013:27; Shemy, 2020:802). The practice of digital storytelling began in the late 1990s and is seen as a developing field (Mirza, 2020:84; Rebmann, 2010:30). People perceive storytelling as a common human interaction (D'Abate & Alpert, 2017:4; McDrury & Alterio, 2003:31).

Storytelling is defined as an:

> *"united framework, including a distinguished beginning, middle, and end that provides details in which characters struggle through time, take action, experience emotions and discover meaning" (Radaideh, al-jamal & Sa'di, 2020:2621).*

There is one significant distinction between traditional storytelling and digital storytelling (DS) when switching from narrative to DS. A number of digital interactive media tools that combine visuals and other media tools for narrative making support digital storytelling (Özkaya, 2022:380). Thanks to information technology (IT), narratives can now be conveyed in countless different ways, making them better and easier to tell (Rieger, West, Kenny, Chooniedass, Demczuk, Mitchell, Chateau & Scott, 2018:2). Digital storytelling is the community practice that makes use of digital technology to write and distribute personal narratives (Gürsoy, 2021:98; Meadows, 2003:189; Rahimi & Yadollahi, 2017:3). Anything that employs digital technology to create a narrative can be considered a digital story (Jauharoh & Friatin, 2017:20; Ohier, 2007:56).

Digital storytelling has evolved into a cutting-edge form of the age-old oral storytelling technique (McLellan, 2006:26; Rieger *et al.*, 2018:2). The sharing of unique stories in a way that can be spread anytime and anywhere over the internet is a crucial component of DS (Chiang, 2020:68; Lashari, Sajid & Lashari, 2022:224; Nassim, 2018:17; Rebmann, 2010:32). There are a few significant highlights in the narrative itself that are often included. The stories should begin with a core notion or answer a query that is important to the storyteller and, preferably, to the audience as well (Sepp & Bandi-Rao, 2015:2; Sitter *et al.*, 2020:2).

A persuasive or captivating narration of a narrative is included in digital storytelling. To grasp the story that is being presented, DS provides a crucial context. Thirdly, DS makes use of visuals to express or further develop sentiments and emotions. Last, but not least, it uses music and other sound effects to support the points spoken (Alexander, 2011:11; Moradi & Chen, 2019:5). It has been demonstrated in literature that DS, which blends the craft of storytelling with a range of interactive media techniques, may be a potent instrument to enhance information transmission and advance awareness (Quraishi, Quraishi, Yadav, Singh, Fasih, Vasquez, Huria, Pande, Mumba, Kamineni & Khan, 2022:10). According to Enobakhare, Orem and Ogar (2013:228), information or education on environmental management creates awareness of the need to protect the environment and to address unfavourable perceptions of environmental management. Awareness creation is an act of making individuals informed or learned about a situation or phenomenon (Annune, Agoh & Annune, 2020:6). Awareness is generally defined as *"an understanding of the activities of others, which provides a context for your own activity"* (Dourish & Bellotti, 1992:107). Awareness *"involves knowing who is 'around', what activities are occurring, who is talking with whom; it provides a view of one another in the daily work environments"* (Dourish & Bly, 1992:541). Awareness means *"something exists and is important"* (Jati, Darsono, Hermawan, Yudhi & Rahman, 2019:164).

Comprehension of a situation or issue at the present time, based on knowledge or experience, is referred to as awareness (Bamidele & Awoyemi, 2017:47576). Awareness creation in this study refers to the act of making participants informed or learned about e-waste and GIT practices. Agosti, Andersson, Bringsén and Janlöv (2019:5) suggest awareness promotes change and is a prerequisite for the desired change. The participants felt empowered due to the presence of awareness. In this research, awareness is defined as being completely aware to e-waste and GIT existence in combination with their effects on the environment. Digital stories come in a wide variety of forms, and as a result, they may be divided into three main categories: historical accounts, first-person accounts, and stories intended to educate or enlighten the audience about a specific idea or behaviour (Robin, 2008:224; Şeker, 2016:19).

Personal accounts are types of digital story in which the author describes his/her own experiences (Brailas, 2021:2; Lunce, 2011:77; Şeker, 2016:19). These narratives may centre on emotionally charged and personally relevant events from ordinary life for both the author and the audience (Lang, Laing, Moules & Estefan, 2019:5; Robin, 2008:224). Stories intended to educate or enlighten: this kind of digital narrative's primary objective is to provide instructional resources across a variety of topic areas (O'Byrne, Houser, Stone & White, 2018:2). These intricate narratives may be used by educators to aid pupils understand ideas in a variety of subjects, including physics, innovation, and medical training (Lang *et al.*, 2019:1; Robin, 2008:224). This study will create a digital story to educate or enlighten participants on awareness of e-waste and GIT practices (Özüdoğrua, 2021:445; Robin, 2008:224; Şeker, 2016:19). Events of history stories use digital media to relate historical events that could result in an entirely different kind of story (Barber, 2016:3; Garrety, 2008:13).

4.3 Digital storytelling for empowerment

Since its origin DS has been crucial in amplifying the voices of everyday people especially those belonging to various excluded communities in a society, such as sexual minorities (Bedeley, Carbaugh, Chughtai, George, Gogan, Gordon, Grimshaw, Leidner, Myers, Ortiz, Wigdor & Young, 2019:556; Sevelius, Gutierrez-Mock, Zamudio-Haas, McCree, Ngo, Jackson, Clynes, Venegas, Salinas, Herrera, Stein, Operario & Gamarel, 2020:2009; Valentine, 2016:1). It may however, also make reference to any marginalised and at-risk populations that the media ignores or fails to adequately reflect (Juppi, 2017:34). In this study, information technology technicians and students as participants are considered as examples of excluded communities in the context of the study. Because of their alleged ignorance of the damaging consequences of waste produced by electronic equipment on the biosphere, as argued by a number of authors, they should be viewed as such (Dayaday & Galleto, 2022:534). Snyman *et al.* (2021:92) take it further to identify another exposed to the potential for physical or psychological harm or injury group (pre-school children) due to cyberspace's inherent dangers. It is acknowledged that using digital storytelling may help build relationships based on trust (James, 1996:209; Pandian, Baboo & Yi, 2020:187). Digital storytelling allows people to find and support fresh shared accounts that contradict prevailing narratives within a community or civilisation (Rieger *et al.*, 2018:2; Williams, Labonté & O'Brien, 2003:36).

4.4 Digital story challenges

Because of emotional nature of digital stories and considering how effectively digital storytelling can capture and transmit participants' actual experiences the confidentiality of the storyteller is crucial (Conrad, 2013:3; Grant & Bolin, 2016:48). Every time when sharing and circulating narratives over the internet network, ethical principles should be observed (Gachago & Livingston, 2020:2; Gubrium, Hill & Sarah, 2014:1609). Digital accounts may for instance highlight taboo subjects such as drug misuse and domestic violence. Finding participants in emotional subjects may be challenging and sharing terrible experiences can be upsetting and problematic when naming the violent perpetrators due to ethical issues (Dunford, 2017:323; Gubrium *et al.*, 2014:1609). When making a DS and looking for information online not all the material is in the public domain. It is important to respect other people's copyrights and creative works (Gachago & Livingston, 2020:2).

4.5 Storytelling frameworks

In this section a few of the methods that may be used to create or build a digital story are explained. Writing a preliminary screenplay, creating a storyboard to organise the plot, discussing and revising the plot script, placing the images in the video editor, adding the narrative, transitions, and special effects, and lastly, adding a soundtrack are the typical seven steps in the development of a digital story (Fokides, 2016:104; Kajder, Bull & Albaugh, 2005:40). The premise, character, topic, story architecture, scene structure, and writing voice are the components for creating the digital narrative. Narrative events are directed by the construction of the scene. The story advancement is referred to as a concept. Characters that are active in a story are called characters. The story enlightening in actual life events is described as a theme. Last, but not least, writing voice relates to all the dialogue in a narrative, the language used, and any songs.

Robin and Pierson (2005:710) explored DS use options. They brought in a disruptive version that extends the conventional version with seven elements (Tse, Chan & Chu, 2021:175), namely the story's overarching goal, the narrator's perspective, a compelling subject or questions, the content choice, the author's clear voice, the pace of the story, the use of a meaningful audio accompaniment, the calibre of the photographs, video, and other multimedia components, the economy of the story's details, and excellent grammar and language use (Tse *et al.*, 2021:174). The emphasis is on the storyteller's mastery of the format, word choice, imagery, and musical accompaniment so that the creative process is as impactful for the storyteller as the finished result is for the audience (Abdel-Hack & Helwa, 2014:9; Sawiji, 2016:39). The IMPALA project's Design Model for Podcasting, which classifies DS as a type of podcasting, and two additional frameworks might help with the creation of digital storytelling. (Barber, 2016:4; Ng'ambi, 2008:11). Ten structure variables are included in the IMPALA model: pedagogical justification, medium, convergence, contributors and writers of podcasts, podcasting structure, reusability, duration, style, framework, and system to access. Ohler's continuum model, on the other hand, includes a list of 18 aspects to consider.

Table 4-1 provides a breakdown of the most common technologies used to generate digital narratives.

Table 4-1: Creating a digital storytelling tool (Choo *et al.*, 2020:46)

Aspect / Software & shareware	Performance	Brand
Hardware		
Camera that is digital	Still pictures are produced	Windows/Macintosh

Aspect / Software & shareware	Performance	Brand
Video camera that is digital	Video clips are built	Windows/Macintosh
The Microphone for audio	Recording of narration	Windows/Macintosh
Internet camera	Making and recording digital photos and videos	Windows/Macintosh
Flip application	(Produce) videos	Windows/Macintosh
The scanner device	pictures from photography prints are captured	Microsoft/Apple
Software		
The Avid Free DV application	Video/audio edits	Microsoft/Apple
Photo Story 3/Movie Maker/Image Blender 3 application	Images that are still plus video snippets, create digital stories. Add audio	Windows
The iMovie/ iPhoto video creators	Both still images and video recordings may be used to create digital narratives. Incorporate voice	Apple hardware
The Adobe Photo Shop Elements	Alter images in accounts that are digital accounts	Microsoft/Apple
The Ulead	Used as video editor	Microsoft
The Goldware app	Captures, modifies, edits sounds	Microsoft
The Audacity app	audio is captured and edited	Windows/Macintosh
Software		
The Adobe Premiere Pro app	A professional tool for editing videos	Windows/Macintosh
Shareware		
DVD in Blu-ray Internet site Disk-Read-Only Compact Disc and others	Publish the digital pieces and disseminate them.	

4.6 Digital storytelling and knowledge-sharing techniques

In this section, DS is contrasted with other knowledge-sharing methods used in organisations. Simulations, modelling, codified resources, and symbolic objects are some of the approaches on this list. Simulations are experimental settings that mimic complicated circumstances so that knowledge and experience may be shared. It is an educational method that replicates real-life situations (Pottle, 2019:181; Soule & Wilson, 2002:6). Virtual reality is an emerging method for delivering simulation (Pottle, 2019:181). Modelling is a knowledge sharing technique whereby the audience learns by observing (Salisu & Ransom, 2014:54). Codified resources are formal materials that are provided in a clear and organised manner, such as instructions, textbooks, and standard operating procedures. They are used to share information (Wyatt, 2001:6). Public and formal knowledge is codified (Halonen & Laukkanen, 2008:298). The term symbolic objects refers to the dissemination of information through the viewing of images or photographs that support the central concept (Eppler & Burkhard, 2007:119; Westley & Folke, 2018:1). Codified knowledge is sometimes referred to as explicit knowledge and is easily documented and formed (Asbari, Wijayanti, Hyun, Purwanto & Santoso, 2019:229).

Table 4-2 illustrates how the capabilities of DS stacks up against the above-discussed types of information sharing when they are used separately and independently, assuming identical circumstances and efforts (Soule & Wilson, 2002:6).

Table 4-2: Digital storytelling and modes of knowledge sharing (Soule & Wilson, 2002:7)

Potential aims of knowledge exchange	**A partial list of techniques for exchanging knowledge**				
	DS	Modelling	Simulations	Codified resources	Symbolic objects
Communicating principles and norms	1111	1111	11	1	1
Increasing commitment and trust	1111	1111	111	1	1
Sharing of confidential data	11	1111	111	1	1
Promoting change and unlearning	111	1111	1111	1	1
Making a connection on an emotional level	111	1111	1111	11	11
Presenting laws, regulations, and policies	1	1	1	1111	1111

Explanation: 1111 = Entirely appropriate, 111 = Works fine, but has limitations, 11 = Restricted, but effective, 1 = Not well suited.

4.7 Digital storytelling approaches

Barber (2016:4) highlighted a number of digital storytelling techniques, which will be covered in the parts that follow.

4.7.1 Podcasts and interactive narratives

Podcasts are educational but are intended for listening rather than watching. They can be listened to over the internet or as downloads and are not limited to voice but can contain text and images. As a result, they are considered as one form of digital storytelling (Barber, 2016:5; Ferrer, Shaw & Lorenzetti, 2021:92; Moradi & Chen, 2019:2). Stories that require the reader to physically move between locations while reading them are known as locative or interactive stories. In the interactive environment, the outcome of the narrative can be controlled by his or her choices. The result is not predetermined in these narratives (Jin, Ma & Zhu, 2022:5797).

4.7.2 Transmedia vs multimedia stories

A multimedia story may be described as employing two or more media forms to deliver a news story package on a web site, including word that is spoken or written, audio, static and dynamic photos, and hypertextual aspects (Van Krieken, 2018:4). Contrarily, transmedia DS involves telling stories over several media platforms to provide numerous, distinct, yet related narrative experiences focused on the same theme (Barber, 2016:8; Palioura & Dimoulas, 2022:4). This is not the same as multimedia, when a narrative is told through a variety of mediums. Additionally, it differs somewhat from cross-media storytelling, which involves telling the same tale in several mediums (Barber, 2016:8).

4.8 Digital storytelling that is linear and non-linear

Through a linear form, the author directs the reader or user through a clear path to consume the work. It is implied by the term line*ar* that each component of the work is meant to be experienced again in a particular order (Kulkarni, Thomas, Komorowski & Lewis, 2022:10). Compared to other types of digital storytelling, such interactive narratives or video games, linear storytelling does not offer the same amount of exploration or non-linearity. Similar to conventional forms of narrative, like movies, it progresses linearly from the beginning to the end (Meyer, 2017:9; Spaniol, Klamma, Sharda & Jarke, 2006:256). Nonlinear narratives are storytelling approaches that stray from typical linear patterns. In nonlinear narratives, the order in which events are presented is not chronological, resulting in a more intricate and unusual narrative structure. The audience's perspective of time and events is thrown off balance by this strategy, which may give a narrative depth, intrigue, and a feeling of mystery (Letonsaari, Karjalainen & Selin, 2019:2; Spaniol *et al.*, 2006:252).

4.9 Digital storytelling in practice

Some of the settings where DS has been tested and used are discussed in the following sections.

4.9.1 Digital storytelling in museums

Digital storytelling is proving to be a practical solution for historical sites and museums, especially those that emphasize art, science, and social heritage, to draw visitors who have a variety of relaxing alternatives that may both engage and instruct (Liu, 2020:2; Loannidis, Raheb, Toli, Katifori, Boile & Mazura, 2013:421). It enables museums to reach a bigger audience outside the actual museum location, accommodate various learning styles, and display knowledge in novel ways. Museums can improve the narrative process and make the exhibits more approachable, interesting, and relevant to modern audiences by utilising digital technology (Kontiza, Antoniou, Daif, Reboreda-Morillo, Bassani, González-Soutelo, Lykourentzou, Jones, Padfield & López-Nores, 2020:2; Perouli, 2021:37; Robin, 2016:22). The DS approach may be utilised to produce influence among people, places, and material culture in museums and galleries by utilizing a great potential of artefacts and key social systems (Pandey & Bhattacharya, 2020:1336).

4.9.2 Community contexts for digital storytelling

Practice of DS in communities is said to have the power to improve people's lives and the way they interact with one another despite differences (Gachago, 2016:297). According to a study by Cueva, Kuhnley, Revels, Schoenberg and Dignan (2015:5), DS was useful for promoting cancer awareness. After seeing the digital narrative produced by community health practitioners, the goal was to understand the viewpoints of community members. In another study, DS was used to create awareness about sustainability issues (Tzima, Styliaras, Bassounas & Tzima, 2020:1). In a different research DS seemed to increase community participation and knowledge of the reality of abortion restrictions (Michie, Balaam, McCarthy, Osadchiy & Morrissey, 2018:357).

4.9.3 Digital storytelling in education

Digital tools such as cell phones are in use for pedagogy as technology advances at a rapid rate (Dreyer, 2017:1; Smeda *et al.*, 2014:1). Storytelling, the oldest educational method, significantly advances competency conversation and instruction in children (Poolman, Leseman, Doornenbal & Minnaert, 2017:771). Storytelling was first primarily used in early childhood education as an instructional style and learning aid. Younger students can study subject and develop language abilities by creating, writing, editing, and narrating their own stories or reports by themselves (Nassim, 2018:17; Wang & Zhan, 2010:77). Scanners and other technologies for creating digital storytelling are getting more and more inexpensive (LaFrance & Blizzard, 2013:27; Moradi & Chen, 2019:2). For a reasonable sum of money and a relatively short length of time, the average individual can actually effectively and powerfully record his/her narrative (Tse *et al.*, 2021:174). The use of DS in education has significantly altered as a result of a collaboration between accessible technology and a modern curriculum for the modern classroom (Robin, 2008:222; Tse *et al.*, 2021:174). Technology use as a tool for designing processes in developing messages about one's ideas gives students a space to do so through the use of digital storytelling (Gachago, 2016:297; Shinas & Wen, 2022:2).

When students are encouraged to write their own stories, either alone or in small groups, it is possible that here is where DS is most frequently used (Sadik, 2008:490; Salem, 2022:4; Staley & Freeman, 2017:1). Teachers should be pedagogically and technically equipped to use DS for teaching and learning (Clarke, 2017:2046; Nuroh, Kusumawardana & Destiana, 2021:479; Wang & Zhan, 2010:85). Pupils are more aware of other pupils' behaviour and cultures because of digital storytelling (Darling-Hammond, Flook, Cook-Harvey, Barron & Osher, 2020:131; Eristi, 2014:1).

When compared to other forms of instruction, stories are a more effective way to get students' attention, keep them engaged, and help them learn because they provide a means of bringing information to life, making the theoretical concrete, and gradually introducing disciplinary literacies through the process of making meaning (O'Byrne *et al.*, 2018:2). Basiouny, Ghazy and Baioumy (2016:1) suggested that telling a narrative is primarily a process of creating meaning. Stories are closely associated with education. A learner is prompted to consider what she or he knows while reading the tale, and via frequent modification, cognitive development is tracked. As a result, the narrative is often used in educational settings today to encourage pupils to reflect on and understand the material. The teaching of any educational material is possible via the use of narratives (Basiouny *et al.*, 2016:1). The digital narrative goes beyond merely using technology (Livari, Sharma & Ventä-Olkkonen, 2020:1; Malita & Martin, 2010:3061).

According to Robin and McNeil (2012:38) regarding DS as a tool for pedagogy, additional research requirements are needed. As more instructors become aware of it and learn how to integrate it into their classroom activities, the field is seeing a tremendous growth spurt (Karantalis & Koukopoulos, 2022:4). By including audio, video, and visual components in their lessons, teachers are discovering new methods to engage their students (Robin, 2016:21). Documenting the narrative and locating and analysing the necessary data lead to the development of research abilities (Salem, 2022:2; Sani, Abet & Khalid, 2022:1). Learning how to use various devices, including scanners, digital cameras, and multimedia editing software, such as iMovie, is referred to as developing technology skills (Robin, 2016:25). Managing resources, such as the amount of information in a digital narrative, the amount of time needed to complete it, and other materials, is a component of organisational abilities. Making choices on how to tell the story most effectively and successfully to the audience is a component of presentation skills. Being able to operate in a team or group and assigning duties to the participants requires interpersonal skills (Niemi & Multisilta, 2016:451). To solve problems effectively, one must be able to make decisions and get past obstacles at every stage of the process, from the start to the conclusion of the narrative. Other advantages are: (i) acquiring proficiency in assessing one's own work, as well as that of others, (i) locating sources with which to interact and selecting the inquiries to pose, (ii) writing skills, and (iii) determining point of view, developing a screenplay or piece of material. Figure 4-1 illustrates how Rubino recommends using DS in the classroom (Rubino, Barberis & Malnati, 2018:889).

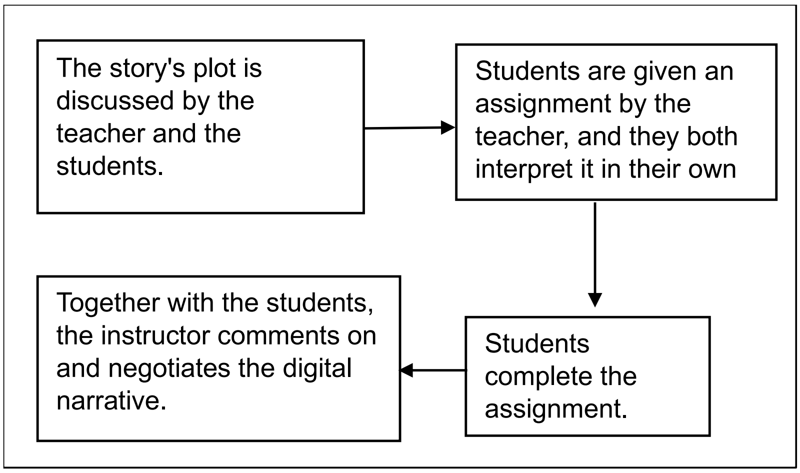


Figure 4-1: Method for employing digital story telling (Rubino *et al.*, 2018:889).

4.9.3.1 Digital storytelling in higher education institutions

Higher education institutions (HEIs) have lately started using digital storytelling as a pedagogy technique to engage students in multicultural classrooms by utilising the power of personal experiences to foster empathy across differences. The teaching technique of digital storytelling provides pupils with a voice in the classroom (Lazareva & Cruz-Martinez, 2021:384; Lowenthal, 2008:353; Staley & Freeman, 2017:1). Gachago (2016:296) believes that the inclusion of DS in HEIs equips people from different backgrounds with a means of grasping and comprehending the systematic inequalities that control our learning environments. Dreyer (2017:1) went on to say that the popularity of DS in HEIs has not really taken off yet, but DS gives students fresh, exciting methods to display their work and think about it.

In several creative ways, the DS has been integrated into classrooms and lecture halls as a teaching tool and a learning tool. Students can write stories about their experiences, discoveries, understandings, and other things to express their learning (Darling-Hammond *et al.*, 2020:101; Robin, 2016:21; Wang & Zhan, 2010:78). There are two distinct DS applications in HEIs (including its creative Web 2.0 storytelling variant), a composition platform and a curricular item (Alexander & Levine, 2008:52). Blogs and other Web 2.0 tools are employed by instructors and students as a composition platform to write in a variety of genres to share personal encounters or experiences, do research, present understandings, and communicate learning in a unique and significant way (O'Byrne et al., 2018:2). Students and teachers can more effectively teach a crucial subject at the object or item platform (Alexander & Levine, 2008:52).

Given DS's determination to convey concepts in a profound and outstanding manner, the examination of this technique is justified. Up until now, students have had access to different techniques for learning about course content with digital storytelling. Through DS, it is possible to develop procedures that will let pupils demonstrate their skills in original ways. (Peñalba, Samaniego & Romero, 2020:2; Silseth, 2013:157).

4.10 Summary

Each source was thoroughly evaluated throughout the chapter, along with comparisons and differences to comparable publications. An examination of the sources was part of the argument evaluating the current level of knowledge on the subject.

It became evident that one needs to differentiate between digital storytelling and storytelling. Digital stories are classified into three major categories; stories designed to inform, historic narratives and personal narratives, each explained in this chapter. The discussion on how digital storytelling can empower individuals and marginalised groups or society, was provided. The transformative power of digital storytelling for communities at economic or cultural level was explained. However, there are challenges in developing digital stories through digital storytelling. These challenges were explained in this chapter. Frameworks for developing digital stories were also identified. Tools to get one to develop digital stories were identified. There was discussion on the comparison between digital storytelling and other knowledge sharing methods. Podcasting and interactive or locative narratives were also explained. A discussion on linear and non-linear digital storytelling was provided. The context where digital storytelling technique is applied was identified and explained. This included its application in higher education institutions.

In the next chapter, the methodology for the study will be discussed. The steps that the researcher will take to investigate and study a topic, as well as the justification for the methods and approaches used to find, gather, and analyse the data that would help the researcher comprehend the problem at hand will be described.

CHAPTER 5 RESEARCH METHODOLOGY

5.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

This Chapter provides literature on prominent research paradigms, including each paradigm's ontology, epistemology, methodologies, and methods. It starts with the definition of a research paradigm and its components. It goes on to determine the suitability of these paradigms for this study. The critical social theory paradigm is found to be suitable for this study. This paradigm ensures that all participants' lives be transformed for the better (Kivunja & Kuyini, 2017:35; Omodan, 2022:278). Here the structure of this study is illustrated in terms of a guiding framework, methodologies and an area of concern or research problem, as suggested for action research studies in the critical social theory paradigm (Checkland & Holwell, 1998a:13; Goede & Taylor, 2019:10). The relevant stages of action research are discussed, which are diagnosing, action planning, action taking, evaluation and specifying learning. The Chapter also explains the data gathering instruments (ANNEXURE D) and the data analysis methods used in the study. The data gathering method are semi-structured interviews, supplemented auto-photography and official documents. Content analysis and critical systems heuristics are used to analyse and evaluate the data.

Other sections for this chapter are presented in the following order: critical systems thinking in Section 5.2. followed by the critical systems heuristics discussion for evaluation and diagnosing phases in Section 5.3. In Section 5.4, an overview of the research paradigms is covered. In Section 5.5, prominent paradigms on research are presented. Discussion on case study research design is in Section 5.6. In Section 5.7, an explanation of the cross-case analysis procedure is provided. Research plan discussion is provided in section 5.8. Presentation of the model to generate themes is presented in Section 5.9. Evaluation and rigour of the method discussion is given in Section 5.10. In Section 5.11, a summary provides the conclusion.

5.2 Critical systems thinking

"*A systems approach begins when first you see the world through the eyes of another*" continues to be one of the most commonly used definitions of systems thinking (Reynolds, 2011:8). One of the many areas where *'systems thinking'* is prominent and seen as having significant potential is evaluation (Cabrera, Colosi & Lobdellc, 2008:299). Systems thinking (ST) is frequently classified as hard systems, structuralist, soft systems, or CSH (Buse, 2013:1096; Gates, 2017:204). The essential notion that systematic thinking may provide us with this goal is the critical application of boundary judgements. A concept that has previously demonstrated both its critical relevance and heuristic efficacy in an emancipatory systems approach known as CSH (Ulrich, 2000:251). According to Gates (2017:202), critical systems heuristics is a subfield of applied systems thinking that is a subfield of critical systems thinking.

Critical systems heuristics incorporates two major schools of thinking. The heritage of systems thinking comes first, followed by pragmatic philosophy (Ulrich & Reynolds, 2010:246). Critical systems heuristics was created in response to criticisms of prior methods of systems understanding (Buse, 2013:1096). To define boundaries around a common issue and guarantee that realistic, practical, and meaningful action is performed, Ulrich provides 12 is/ought questions for stakeholder dialogue. These questions aim to reveal actors' hidden or taken-for-granted attitudes and assumptions (Buse, 2013:1097). Critical systems heuristics interacts with the potential for unfairness, injustice, and inequality in systems study and practice, in contrast to other systems methods (Buse, 2013:1096).

Critical systems thinking borrowed several potent ideas from systems thinking itself, including the terms system, element, relationship, boundary, input, transformation, output, environment, feedback, emergence, communication, control, identity, and hierarchy (Jackson, 2001:234). Social theory and systems thinking have complementary strengths and shortcomings, which critical systems thinking acknowledges. The goal of critical systems thinking is to combine the advantages that social theory and systems thinking both provide. Social theory offers resources for improving current systems methods and creating brand-new ones (Jackson, 2001:234).

Critical and social awareness, methodological and theoretical complementarity, and a dedication to human liberation form the basis of critical systems thinking. Its objective is to promote societal advancement (Flood, 2010:279).

- Critical awareness: two different forms. The first is by bringing up and challenging the ideals and assumptions that are built into every systems design. The second examines the advantages and disadvantages, as well as the theoretical foundations of systems approaches and related practices.

- Social awareness: is about understanding the social norms and behaviours that determine whether certain types of behaviour are acceptable in society. For instance, it acknowledges the scientific method's supremacy in Western society and its reliance on learning by generalisations. Action research's method of handling learning, which involves transferring and adapting study findings from one setting to another, is hampered by the cultural mode of science.

- Theoretical complementarity: must, for two very compelling reasons, adhere to the interests of human emancipation. Firstly, critical systems thinking must avoid falling victim to the knowledge-power trap that leads to the development of its own conventional wisdom. Secondly, a single systems approach cannot effectively address the range of difficulties brought forth in the previous paragraph. The article’s prior brief evaluations of systems and soft systems thinking show that each theoretical framework has its drawbacks. All forms of the systems approach must be developed in a complimentary and informed manner.

- Methodological complementarity: accompanies theoretical complementarity side by side. Each conceptual framework includes methodological guidelines for action. For each of the three issues with human emancipation mentioned above, critical systems thinking acknowledges the necessity for distinct sets of methodological approaches. Making use of these promises in the field of practice is quite difficult. Thankfully, a group of scholars who are actively investigating strategies for putting the six commitments of critical systems thinking into practice still hold them dear.

- Human emancipation: shows care for people's potential development and overall well-being. In contemporary civilisations, these two aspects of human existence can become severely constrained. Firstly, with the current push for effectiveness and efficiency, people could feel as if they have transformed into reengineering tools. When cultural and intrapsychic forces shape outcomes covertly, people may believe that participative work methods have little meaning for them. Secondly, people may feel that the roles that knowledge-power has predetermined for them are unjust and have limitations.

Through the investigation of oppressive societal institutions and subsequent intervention to have them altered, critical systems thinking seeks to liberate the oppressed (Jackson, 1991:132).A systems thinker approaches the world as greater wholes or systems with goals, where components work together to achieve the system's main goal. Over time, the concept of systems thinking evolved from hard systems to soft systems to critical systems thinking (Goede, 2014:3). The approaches that go along with critical systems thinking were created specifically to enable analysis of complex societal issues and action to address such issues. Early systems-based approaches, like operational research were effective at solving some clearly defined problems, but they had drawbacks when dealing with complicated issues involving several parties who frequently had divergent opinions (Jackson, 2001:233). According to Jackson (1991:132) critical systems thinking promotes reflection and emancipation. Below is a quick overview of critical systems thinking concepts. Literature offers a thorough analysis. The Checkland and Howell FMA model is used to structure this discussion (Checkland & Holwell, 1998b). Critical systems thinkers believe that the world is in need of intervention because it is conflicting and inconsistent (Ulrich & Reynolds, 2010:245). Methodologies, such as CSH help operationalise critical systems thinking. Critical systems heuristics is a subfield of critical systems thinking that offers a theoretical foundation and practical (discursive) framework for critical systems thinking. It does this by providing a framework that is conceptual for practice that is critical and aware (Reynolds, 2011:38; Ulrich & Reynolds, 2010:243). Figure 5-1 depicts Framework, Methodology and Application (FMA) model.

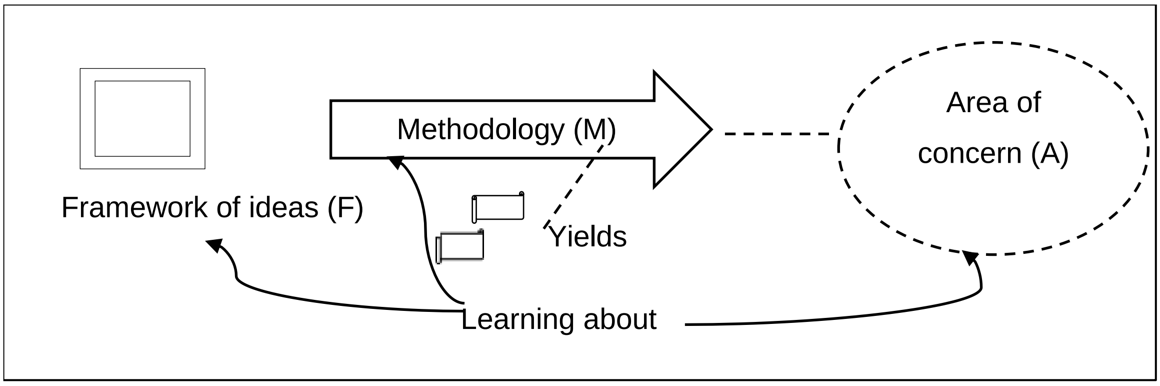


Figure 5-1: The FMA model (Checkland & Holwell, 1998b)

The F of the FMA model outlines the conceptual framework that underpins a methodology (M) that is used to address a problem area (A). On all three levels, learning happens. The three levels (F, M, and A) are utilised to describe the various levels of critical systems thinking in this discussion. Critical social theory serves as the philosophical foundation (F) for critical systems thinkers. Ontologists who practice critical social theory hold the view that the world is not essentially harmonious. Hence, one must consider paradoxes to comprehend, justify, and possibly affect change. Diverse perspectives can be perceived as manifestations of and tools in a power struggle between management and employees, or between system developers and users. Criteria for critical systems practices can be found on a methodological (M) level in critical systems thinking. The five main systems thinking that are critical commitments are as follows:

- The goal of critical systems thinking that is critical shows critical awareness. The uncertainties and thinking of present and potential designs should be scrutinized considering this critical knowledge. Assessment of foundations that are theoretical in nature is important for the various systems methods, techniques, and procedures.

- Critical systems thinking demonstrates social awareness. Because of this social awareness, it is important to understand the organisational and societal influences that influence the employment of different systems theories and intervention techniques at particular periods. Practitioners of systems should now more than ever carefully consider the outcomes of their decisions.

- The goal of critical systems thinking is to emancipate people. It aims to attain the fullest possible development of each person's potential. This is done by improving the standard of living and working conditions in the organisations and societies where they operate. Methodologies work to advance the organisations' and society's technological, practical, and emancipatory interests.

- Critical systems thinking is dedicated to the informed and complementary development of all the various systems thinking theoretical stances. This implies that many systemic points of view must be recognised.

- The complementary and informed application of systems approaches in practice is central to critical systems thinking. It is necessary to use an approach that respects the other four aspects of critical systems thinking.

5.3 Critical systems heuristics

Critical systems heuristics is applied for the diagnosing and evaluation phases of AR. A summary of CSH as framework for evaluation is given. Three main issues are represented by CSH. Firstly, the goal is to improve the critical (reflective) competence of everyone, not just highly skilled professionals, and decision makers. Secondly, reflective practice cannot be supported solely with theoretical means. It also needs heuristic assistance in the form of discussion points and tools that are useful in actual practice. Thirdly, CSH might give us a helpful place to start when figuring out how to methodologically meet the needs for such a reflective practice approach (Ulrich, 2005:1). One crucial criticism is that CSH should not be viewed as a substitute for other systems techniques, but rather as an addition to them. This notion of complementarity has inspired several critical systems theorists to examine CSH together with several other systems methodologies and attempt to demonstrate its suitability for usage in various circumstances. It is stated that CSH is most helpful when we are subjected to coercive circumstances (Midgley, 1997:37), thereby giving us a means of identifying and settling disputes between interested parties (Zawahri, 2022:5). The framework can be used collaboratively with affected parties to address the CSH questions from various perspectives and create a foundation for criticism by parties who have less power than those who are directly involved in planning or implementing an intervention. This is how it is most emancipatory (Nicholas, Foote, Kainz, Midgley, Prager & Zurbriggen, 2019:357). Someone who solves issues can identify what is relevant, who ought to help him/her in doing so, and how to handle conflicting viewpoints among affected stakeholders using critical systems heuristics (Ulrich & Reynolds, 2010:245). According to O'Hara and Taylor (2023:5) CSH is a framework for reflective practice that calls for practitioner's critical competence growth to participate in systems thinking and reflective discourse to pinpoint a system's dominant values. A CSH framework is reflective practice to focus on the systematic analysis and to debate the contextual assumptions and the various viewpoints they inform. Critical systems heuristics is a conceptual framework for reflective practice rather than a methodology that may be chosen on its own (Ulrich, 2003:327). Critical systems heuristics is said to be supported by three pillars (Ulrich, 2005:1). Firstly, heuristic techniques are used to identify and analyse key issue elements, assumptions, and questions, and secondly, it is a critical approach, which does not have only one single correct answer and it encourages processes of reflection and discussion about competing hypotheses. Thirdly, it is systems thinking, as all definitions of problems, suggestions for solutions, and evaluations of results are dependent on prior assessments of the pertinent whole system that needs to be examined (Ulrich, 2005:1).

Boundary critique, the founding principle of CSH methodology, enables problem solvers to approach boundary decisions in a methodical and critical manner (Ulrich & Reynolds, 2010:245). To decide what features of a scenario are to be regarded significant, who should be involved in determining it, and how conflicts should be managed among relevant stakeholders, CSH includes a checklist of boundary questions to be posed in the is and ought to modes. To describe the normative content of systems, CSH looks at four fundamental categories: the foundation of motivation, the basis of power/control, the basis of knowledge/expertise, and the basis of legitimacy. These categories are defined below (Ulrich, 2005:7).

- The clients are identified as the source of motivation in the basis of motivation because they are active in the design process, care about the system's purpose, and are interested in potential system improvements.

- The basis of power/control identifies the decision makers who direct the system. They participate in the design process to identify sources of control inside the system (components) and outside the system (environment), and they consider how the system's advancements depend on the components and environment.

- The planners or designers who are the sources of knowledge, experience, and/or skill are indicated by the base of knowledge or expertise; they implement the systems and should strive to ensure their success.

- The basis for legitimacy identifies the system-affected witnesses, who are typically not involved in the design and/or execution of the systems but hold the three stakeholder groups described above ethically accountable (they may have conflicting world views amongst them that needs to be reconciled).

The actual situation, or actual mapping, is determined by the checklist of boundary questions to be asked in the is mode, and the ideal situation, or ideal mapping, is determined by the boundary question to be asked in the ought to mode. Ulrich (2005:8) poses the following questions:

i Motivation

- Who is (ought to be) the client? That is, whose interests are (should be) served?

- What is (ought to be) the purpose? That is, what are (should be) the consequences?

- What is (ought to be) the measure of improvement? That is, how can (should) we determine that the consequences, taken together, constitute an improvement?

ii Sources of power/control

- Who is (ought to be) the decision maker? That is, who is (should be) in a position to change the measure of improvement?

- What resources are (ought to be) controlled by the decision maker? That is, what conditions of success can (should) those involved control?

- What conditions are (ought to be) part of the decision environment? That is, what conditions can (should) the decision maker not control (e.g., from the viewpoint of those not involved)?

iii Sources of knowledge/expertise

- Who is (ought to be) considered a professional? That is, who is (should be) involved as an expert, e.g., as a researcher, planner or consultant?

- What expertise is (ought to be) consulted? That is, what counts (should count) as relevant knowledge?

- What or who is (ought to be) assumed to be the guarantor of success? That is, where do (should) those involved seek some guarantee that improvement will be achieved, for example, consensus among experts, the involvement of stakeholders, the experience and intuition of those involved, political support?

iv Sources of legitimation

- Who is (ought to be) witness to the interests of those affected, but not involved? That is, who is (should be) treated as a legitimate stakeholder, and who argues (should argue) the case of those stakeholders who cannot speak for themselves, including future generations and non-human nature?

- What secures (ought to secure) the emancipation of those affected from the premises and promises of those involved? That is, where does (should) legitimacy lie?

- What worldview is (ought to be) determining? That is, what different visions of improvement are (ought to be) considered, and how are they (should they be) reconciled?

This study used the twelve boundary questions to define the boundary judgements of a problem to consider the stakeholders who should be involved in determining the relevant aspects, and how to handle divergent viewpoints among stakeholders by identifying the relevant motivation, power, knowledge, and legitimacy.

5.4 Overview of research paradigms

A set of beliefs in a community of scholars in conducting research is called research paradigm (Brown & Dueñas, 2020:545). Any scientist or researcher must be aware of the philosophical foundations of research paradigms (Jackson, 2013:49; Kivunja & Kuyini, 2017:26; Omodan, 2022:275). Understanding the philosophical foundations of paradigms in research is important because each paradigm has a unique set of assumptions about reality and knowledge that support its own research methodology (Kaushik & Walsh, 2019:1; Scotland, 2012:9; Yong, Husin & Kamarudin, 2021:5857). It is crucial that researchers frame their research inside a certain paradigm as a result. It is understood that the chosen paradigm's beliefs, standards, and values will inform and guide the study (Kivunja & Kuyini, 2017:27; Omodan, 2022:276). A paradigm consists of ontology, methods, epistemology, and methodology (Alharahsheh & Pius, 2020:40; Kaushik & Walsh, 2019:1; Scotland, 2012:9). Studies that reflect philosophical knowledge, including foundations to ascertain the truth, are the subject of epistemology (Kamal & Lin, 2019:1390; Oliver, 2010:35). An approach or strategy that should be used to address a research issue is known as a methodology (Ikram & Kenayathulla, 2022:42; Kamal & Lin, 2019:1391; Kothari, 1990:8). Methods are the tools that a researcher employs to conduct research operations, such as collecting data, and it also includes tools, such as grounded theory or statistical analysis to analyse and report findings (Alharahsheh & Pius, 2020:40; Chu & Ke, 2017:284; Kothari, 1990:7).

5.5 Research paradigms

The four paradigms deemed to converge on information technology studies have been identified as positivist, interpretive, critical social theory (CST) and design science research in no particular order. The foundations on which these paradigms are built are discussed below. They include methodology, methods, ontology and epistemology.

5.5.1 The paradigm of positivism

For positivist researchers, truth is assumed to be objective and apart from the inquirer and the subject of the enquiry (Junjie & Yingxin, 2022:10; Ryan, 2018:4). As a result, neither the researcher nor the research participants can affect how the study turns out (Mwita, 2022:619). In a comparable study setting, the same results will be obtained with other participants and researchers. The validity of the research is jeopardised if the asker exerts influence or if the researcher has personal prejudices. This needs to be understood, and if there are any suspicions, action must be taken to guarantee that preventive measures are used to regulate the study settings. Generalisation and replication are possible as long as these precautions are rigorously followed (Guba & Lincoln, 1994:110; Kaushik & Walsh, 2019:1). It is entirely unbiased, scientific, and experimental and totally positivistic (Kumatongo & Muzata, 2021:17). The hypothetical deductive method is a cyclical procedure that starts with theory from the literature in order to (i) develop testable hypotheses, (ii) plan an experiment by operationalising variables (i.e., choosing variables to manipulate and measure through group assignments), and (iii) carry out an empirical study, based on experimentation (Park, Konge & Artino, 2020:690).

5.5.1.1 The ontology and epistemology of positivism

Pure objectivism and realism constitute positivism's ontological position. Positivists contend that there are no multiple truths, there is only a single truth that is independent of anybody's assumptions or perceptions (Brown & Dueñas, 2020:548; Junjie & Yingxin, 2022:11). When feasible, positivists strive to stay out of the inquiry process and are value free (Kivunja & Kuyini, 2017:32; Mazur, 2021:4). Empirical results (facts) are governed by the natural principles of cause and effect rather than by human conceptions or concepts (Irene, 2014:5; Park *et al.*, 2020:691).

5.5.1.2 Positivistic methodologies and methods

When doing positivist research, the technique is aimed towards understanding connections, such as a nomothetic approach. A nomothetic approach uses scientific methods to create generalizations and acquire objective information (Park *et al.*, 2020:692). Methods that are deductive in a study may be mandated by positivists (Mohajan, 2020:50; Rehman & Alharthi, 2016:54). The deductive method is known as top-down because it chooses an existing theory and narrows it down to a hypothesis that is truly testable to either validate or invalidate the theory (Shin, 2019:301). Different approaches can be used to develop positivistic research investigations (Aliyu, Bello, Kasim & Martin, 2014:82). For instance, cross-sectional or longitudinal research designs can be used in developmental positivism (Cook & Ware, 1983:2; Makombe, 2017:3367). The developmental study investigates how traits within a specific population may change over time (Plano-Clark, Anderson, Wertz, Zhou, Schumacher & Miaskowski, 2014:3). The length of the study's execution is what separates cross-sectional studies from longitudinal research (Hudson, Thieken & Bubeck, 2020:644; Rafferty, Walthery & King-Hele, 2015:4).

Survey research is another type of study that can be done using a positivist approach because the researcher is trying to record current phenomena (Rahman, 2017:106; Williams, 2007:67). Correlation studies are a type of positivistic study as well. Studies using correlation are used to find connections between groups or between two or more variables within a single group (Pace, 2019:56; Williams, 2007:67). Observational studies seek to record information about physical occurrences while objectively observing them in their natural environment (Mann, 2003:60; Zangirolami-Raimundo, Echeimberg & Leone, 2018:356). This paradigm's research, for instance, relies on deductive reasoning, the creation of hypotheses and their testing, mathematical equations, the provision of operational definitions, extrapolations, and expression to arrive at a result (Kivunja & Kuyini, 2017:30).

5.5.1.3 Suitability of the positivist paradigm

The paradigm findings are found wanting in terms of insight depth regarding problems that are societal. The majority of the results are cause-and-effect and descriptive explanations (Makombe, 2017:3368). This study's goal is to empower participants, not to make generalisations. A researcher cannot view or study human ideas and experience’s objective. Therefore, from a completely objective standpoint, evidence and knowledge derived from experiences and ideas cannot be regarded as legitimate (Rehman & Alharthi, 2016:53; Uduma & Sylva, 2015:46).

5.5.2 Interpretive paradigm

Considering that it was created as a reaction to positivism, the interpretative paradigm is also referred to as anti-positivism (Mark, 2010:7; Rehman & Alharthi, 2016:55). According to the interpretivist view, there are several realities and no one objective, realistic reality (Haigh, Kemp, Bazeley & Haigh, 2019:3; Mason, 1996:4). Understanding different people's views and understandings helps us comprehend reality, thus the focus here is on analysing different people's stories (Flick, 1998:6; Kovács, Kiss, Kassai, Pados, Kaló & Rácz, 2019:360).

5.5.2.1 The ontology and epistemology of the interpretive paradigm

The researcher is inseparable from the reality's entities and is constantly a part of reality (Omodan, 2022:277). There are several realities, according to interpretivist experts, and not only one (Brown & Dueñas, 2020:548; Mason, 1996:4). Multiple realities refer to a phenomenon where a matter is understood from a variety of personal experiences. In this paradigm, knowledge is said to be subjective as it is created socially (Cresswell, 1998:15; Haigh *et al.*, 2019:3; Marshall & Rossman, 1999:7). The interpretivist paradigm, which offers an understanding of human behaviour that is not constrained by the traditional positivist approach, has gained more and more traction in the social sciences (Omodan, 2022:277).

5.5.2.2 Interpretivist methodologies and methods

Researchers can learn about participants' subjective interpretations and worldviews through interpretivism techniques, such as participant and non-participant observation (Kura, 2012:7; Ryan, 2018:9). Often, non-participant observation is used to rule out the researcher’s biases in other methods and to reveal the differences in what people say and do. Non-participant observation can be either covert, observing research subjects without them knowing that they are being observed at all or overt, where the participants know the researcher is present, but they do not interact (Jones & Smith, 2017:98). The bottom-up method of study is used by interpretivist scholars (Shin, 2019:302). Inductive reasoning is the strategy used in this case, where the research process begins with observations. The researcher gathers (rich, qualitative) data and looks for trends, building up to further generalizations or theoretical explanations (Ljungström, Sarenmalm & Axberg, 2020:2; Maguire & Delahunt, 2017:3354). Researchers in this paradigm believe that only through the perspective of those involved in the current investigation can the social reality be comprehended (Rehman & Alharthi, 2016:56).

5.5.2.3 Suitability of the interpretive paradigm

Understanding the world or the issue through the perspectives of the participants is what the interpretative paradigm is all about (Flick, 1998:6; Hammarberg, Kirkman & de Lacey, 2016:498; Mason, 1996:4). However, researchers who adhere to this paradigm stop there, rather than taking steps to empower or emancipate study participants by using their interpretations to address an issue (Okesina, 2020:61). The goal of interpretative research is often to make a new discovery and develop ideas that have solid empirical support (Darby Jessica, Fugate Brian & Murray Jeff, 2019:398; Flick, 1998:5). Only by understanding participants' viewpoints, could this study seek to empower them. Participants must be given more authority over their opinions rather than just knowing them. This paradigm is not ideal for this study.

5.5.3 The design science research paradigm

Decision support systems and modelling tools are two examples of the novel IT artifacts that the DSR paradigm aspires to create (Gregor & Hevner, 2013:337; Hevner *et al.*, 2019:3; Weber, 2010:2). Engineering is where design science study began, and it focuses on the science underpinning the creation of artefacts (Elragal & Haddara, 2019:3). Vom Brocke, Hevner and Maedche (2020:2) stated the objective of DSR as:

> *"To generate knowledge of how things can and should be constructed or arranged (i.e., designed), usually by human agency, to achieve a desired set of goals; referred to as design knowledge."*

5.5.3.1 Ontology and epistemology of design science research

It is concerned with the scientific investigation of design and the use of the design process in the systematic and scientific creation of knowledge about design and utilising design (Peffers, Tuunanen & Niehaves, 2018:130). Building and using the planned item (artefact) demonstrates knowledge and comprehension of a problem and solution (Hevner & Ram, 2004:75; Scribante, Pretorius & Benade, 2019:145). Put differently, the goal of DSR is to make it possible to generate knowledge by creating new artefacts (Adebesin & Kotzé, 2017:259; Scribante *et al.*, 2019:143). The creation of artefacts, primarily IT systems and applications, constitutes the ontology of DSR in information systems (Adebesin & Kotzé, 2017; Livari, 2007:52; Weigand, Johannesson & Andersson, 2021:1). Design science research produces two different sorts of knowledge. Knowing about natural occurrences and the rules and regularities controlling those phenomena is known as descriptive knowledge. On the other hand, prescriptive knowledge refers to the understanding of how intended or constructed artefacts work (Gregor & Hevner, 2013:339; Niehaves & Ortbach, 2016:304).

5.5.3.2 Methodologies and methods of design science research

The DSR methodology is developmental (Elragal & Haddara, 2019:3; Peffers, Tuunanen, Rothenberger & Chatterjee 2007:6; Weber, 2010:6). Models, constructs, instantiations, and methods are the four types of design artefact that DSR produces (Hevner *et al.*, 2019:3; Venable, 2006:2). Unless the artefacts are assessed after they are made, they are just hypothesised to answer the problem(s) (Venable, Pries-Heje & Baskerville, 2016:78). Some methods for assessing artefacts include the ones listed. They can be compared to other current solutions or assessed for their effectiveness and efficacy in raising the problem at hand (Venable, 2006:4; Venable *et al.*, 2016:78). The problem should be grasped comprehensively, thereby enhancing the quality of the artefacts and the process of design (Coetzee, 2019:291).

5.5.3.3 Suitability of the design science research paradigm for this study

Research in the field of design science focuses more on original designs than the situational environment in which the artefact will be utilised. The interplay between the artefact and the organisational environment is what gives rise to it, but design science study misses this (Cronholm, Göbel & Hjalmarsson, 2016:8; Sein, Henfridsson, Purao, Rossi & Lindgren, 2011:37). The design of an artefact intended to address organisational issues is appropriate for the DSR paradigm (Elragal & Haddara, 2019:3; Hevner, Ram, March & Park, 2004:77). The study is transformative. The aim is to empower the partaker through the creation of awareness. Therefore, the DSR paradigm cannot be used for this investigation.

5.5.4 Critical social theory paradigm

According to researchers who adhere to this paradigm, research must attempt to guarantee that all participants' lives are improved (Mertens, 1999:4; Okesina, 2020:61). It is therefore also known as the transformative paradigm. Critical theorists argue that because they have attained liberation, they are more competent than others to analyse and change society, which is why they are criticised for its elitism (Mark, 2010:10). Nevertheless, it is a useful paradigm for transformational research when used properly (Makombe, 2017:3368; Omodan, 2022:278).

5.5.4.1 Ontology and epistemology of critical social theory

Historical and critical realism serve as the ontological pillars of critical social theory study (Carlsson, 2005:96; Ryan, 2018:2; Scotland, 2012:13). The idea of historical realism holds those values such as social, political, ethical, and gender form reality across time (Brown & Dueñas, 2020:548; Scotland, 2012:13). According to critical realism, reality is made up of several levels, and it exists independently of people (Archer, Bhaskar, Collier, Lawson & Norrie, 1998:41;

Banifatemeh, Shields, Golabi, Ghoreishi & Bayani, 2018:58). The importance of knowledge that is subjective is acknowledged by critical realism (Mungai, 2018:3; Wynn & Williams, 2012:787). According to Westaway, Kaiser and Graven (2020:1234) critical realism acknowledges that knowledge is never absolute. As a result, knowledge is not final. This paradigm entails empowering both the subjects and the researcher, as opposed to the interpretative paradigm (Lee *et al.*, 2011:129; Okesina, 2020:61; Ross, 2017:3).

5.5.4.2 Methodologies and methods of critical social theory

Action is the goal of scholars in this paradigm not just a mere exploration (Mahmoud *et al.*, 2018:3). Many people believe that action research is the most transformational research methodology, and it is appropriate for information systems research (Avison, Kock & Malaurent, 2017:630; Baskerville & Wood-Harper, 1996:235). The approach is ideographic in nature and cyclical. Because it incorporates the repetitive steps: diagnosing, action planning, action doing, assessing, identifying learning, action research (AR) is cyclical. It is ideographic in that it seeks to learn new things by looking into and comprehending the people who are touched by them and their subjective experiences (Fournier, 1998:347; Gibertonia *et al.*, 2016:176). Action research aims to improve participant situations while facilitating the generation of both theoretical and practical knowledge (Oksiutycz & Azionya, 2017:196).

5.5.4.3 Critical social theory paradigm is appropriate for this inquiry

The CST paradigm seeks to emancipate individuals by providing empowerment in addition to comprehending the issue from their perspective (Bednar & Welch, 2012:144; Lee *et al.*, 2011:129; Molloy, 2021:324; Renault, 2016:18). The CST is most appropriate for this study since it places a strong emphasis on enhancing the human condition. By creating knowledge of GIT and e-waste practices at HEIs, empowerment is attained in this study.

5.6 Case study research design

The case study method is helpful to apply when trying to understand a topic, event, or phenomenon in depth and in the context of real-world experience (Crowe, Cresswell, Robertson, Huby, Avery & Sheikh, 2011:1; Taherdoost, 2021:27). A case study type can either be single or more than one (Green, Hanckel, Petticrew, Paparini & Shaw, 2022:6). These two categories, however, might be either narrow or broad. Single case studies are a one-time experiment that can be used to thoroughly examine a topic, obtain a preliminary finding for the subsequent extended multiple groups of cases, and study long-standing theories. Different units are covered by multiple case studies, and the number of units can significantly influence the study's findings.

The results of the units under consideration could be the same or opposite. The number of units analysed in holistic cases, which study one unit, and embedded analyses, which analyse two or more sub-units, is a crucial consideration.

Types of case studies are discussed below:

- Explanatory: With the purpose of fully comprehending the phenomena in the data, they investigate both the surface and deep levels of the data. In complex casual instances or cases, data are utilised to replicate a phenomenon's pattern (Sibbald, Paciocco, Fournie, Van Asseldonk & Scurr, 2021:292).

- Exploratory: This kind of case study is utilised to get a basis for more thorough research. Prior to generating the research question and study hypothesis, it assists in data collection to achieve a protocol without considering in-depth elements. Pilot studies are regarded as an example of this form of case study (Paparini, Green, Papoutsi, Murdoch, Petticrew, Greenhalgh, Hanckel & Shaw, 2020:3).

- Descriptive: In this form of case study, the researcher seeks to describe the occurrences that occurred in the data as it was collected. To obtain phenomenon description, the researcher needs a description-basis theory. This presents challenges because the theory could fail at the initial step and cause other issues in the subsequent stages of the study. Descriptive case studies are used to describe journalistic descriptions (Patnaik & Pandey, 2019:167).

- Prospective: The goal of this kind of case study is the process' outcome. For example, a prospective case study is one in which researchers watch a group of patients over time to see what happens to them (Talari & Goyal, 2020:398).

- Retrospective: In this kind, researchers consider the historical data relevant to their study topic. For instance, while examining the outcomes of a particular sickness, they collect past patient data to compile risk variables (Talari & Goyal, 2020:398).

- Intrinsic: In this kind of case study, the researcher's interests serve as the study's subject (Patnaik & Pandey, 2019:167).

- Instrumental: The individuals provide observers with more information than just what happens in the setting (Crowe *et al.*, 2011:2). A case study can be defined in a variety of ways. According to Stake (1995:273) a case study is both the vehicle through which we learn about the case and the culmination of that learning. Bhatta (2018:74) defines a case study as a thorough investigation of the complexity and distinctiveness of a given initiative, policy, institution, programme, or system in a real-life environment from several viewpoints.

The case study has the qualities listed below:

- A case's definition is constrained (a case inside a bounded system, meaning that the subject of the study can be defined or characterised within certain bounds). A case needs to have a time and location limit (Sibbald *et al.*, 2021:292).
- An extensive comprehension of the case should be given in a case study (Coombs, 2022:2).
- Data is gathered through a variety of techniques, including focus groups, interviews, field notes, documents, autobiographies, historical documents, and more (Taherdoost, 2021:29).
- The type of data analysis depends on the case being studied. In fact, a number of case studies combine qualitative and quantitative methods (Bhatta, 2018:73).
- For case study research to produce effective descriptions, themes must be successfully identified (Bhatta, 2018:74).
- Case studies have importance, since they are continuous in nature and offer findings provided by the researcher regarding the meaning acquired from the case (Coombs, 2022:2).

5.7 Cross-case analysis for the four cases

The replication issue becomes relevant in multiple case studies, where a literal replication logic can be used to predict similar results, or a theoretical replication logic where contrasting results are sought for predictable reasons (Ridder, 2017:287). The researcher compares the four situations in this study. Analysis of cross-case in this study is done at the diagnosing and evaluation phases of the AR cycle for the study. The goal to perform cross-case analysis is to determine the similarities or differences between the four cases in order to replicate the findings (Baxter & Jack, 2008:548). There are no strict guidelines on the number of instances (cases) needed to fulfil the replication strategy's requirements in the multiple-case studies design (Zach, 2006:9). The strategy to compare two cases at a time is shown in Figure 5-2. Firstly, case 1 (university of technology) and case 2 Technical and Vocational Education and Training (TVET) college will be compared. Secondly case 3 (TVET college) and case 4 (university) will be compared. Figure 5-2 illustrates how cross-case analysis is done for the diagnosing and evaluation phases pf the AR cycle.

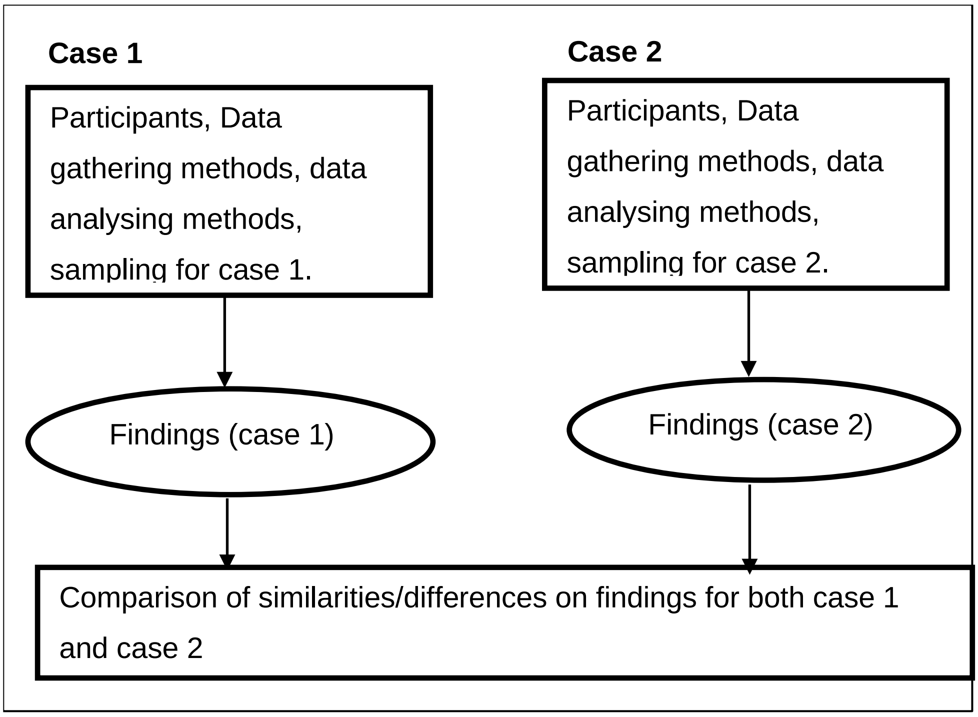


Figure 5-2: Process to compare two cases at a time

When doing analysis between and within cases, information per case should be identified and categorised. Unimportant information should be ignored (Quintão & Andrade, 2020:267). Finally, all the cases will be compared for similarities or differences at once (Figure 5-3). The same sequence of cross-case analysis explained here is also applied in the evaluation phase.

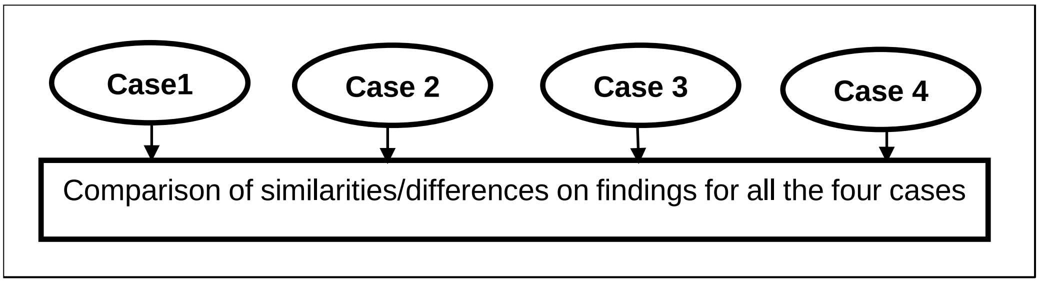


Figure 5-3: Process to compare all the four cases at once

5.8 Plan for a study

The study's goal is the emancipation of participants and hence the CST perspective is utilised (Asghar, 2013:3124; Jokonya, 2016:858; Molloy, 2021:324). To organise and carry out the research, action research is used as the guiding research approach. It is utilised from a CST standpoint. Action research steps are structured within the FMA framework and complemented for more detail by suitable methods as required. For instance, the researcher applies DSR techniques into the design stage of the AR method used in this study to produce a quality artefact (the digital story). Design science research’s appropriateness for the creation of appropriate artefacts is the basis for the decision to incorporate it in the creation of the digital story (Elragal & Haddara, 2019:3; Hevner *et al.*, 2004:77).

5.8.1 The study's action research approach

Figure 5-4 shows the five iterative processes of AR – diagnostics, action planning, action doing, assessing and describing learning.

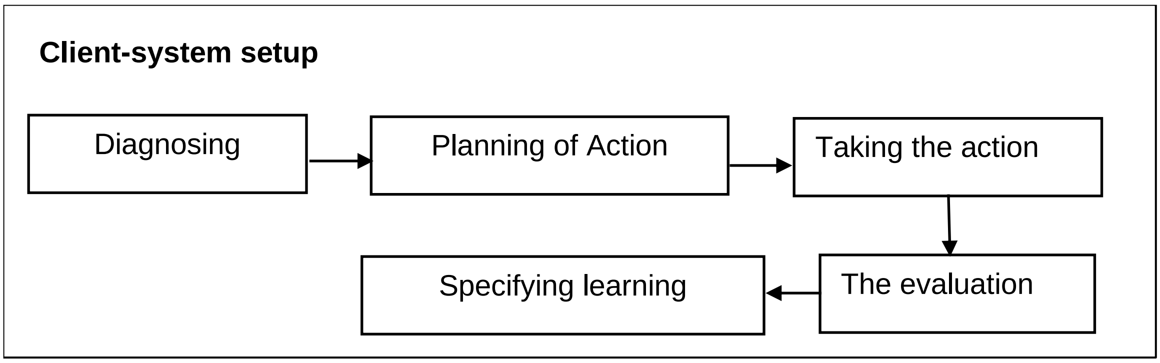
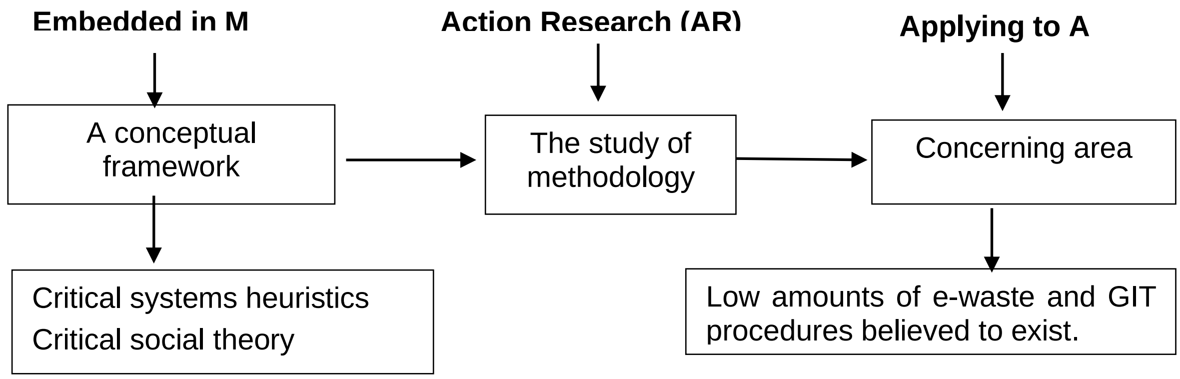


Figure 5-4: Process of the action research cycle (Baskerville, 1999:13)

Since AR is cyclical, subsequent action plans will need to be modified in successive iterations until emancipation occurs (Goede & Taylor, 2019:6). This AR research aims to achieve two goals. It incorporates both learning from results and quick social problem remedies, culminating in the following addition to scientific knowledge and theory, both deliberate and unexpected, as stated by numerous writers (Johnson, 2012:9; Mohajan, 2018:10). In agreement with the proposal of Checkland and Holwell (1998a:13), this connects to the F, M and A components. Checkland and Holwell (1998a:13) assert that utilising a framework (M) to address an issue or problem (A) within a philosophical framework (F) can result in learning. In order to investigate and resolve a problematic societal context, i.e., concerning area (A), and liberate impacted stakeholders, AR, when used as a CST practice, involves a methodology that is suitable (M), and which embodies the notions of philosophy of a particular framework of ideas (F) (Avison *et al.*, 2017:630; Checkland & Holwell, 1998a:13). The philosophical framework (F) level of Werner Ulrich's CSH framework is applied in this investigation. It uses concepts from the CST paradigm and is conceptually based on Kant's writings (Reynolds, 2011:38). Frameworks, such as CSH implement the critical social theory paradigm (Hutcheson, Morton & Blair, 2023:1). Figure 5-5 shows F-, M-, and A-related action research steps in this study.



1. Diagnosing phase
   Data gathering methods: interviews, auto-photography, institutional documents
   Data analysis methods: content analysis, critical systems heuristics
   Activity: determine participants' level of awareness about e-waste and GIT practices.
2. Action planning phase
   Data analysis methods: critical systems heuristics and content analysis
   Activity: create artefact (digital story).
3. Action taking phase
   Showing the digital story to the participants
4. Evaluation phase
   Data gathering method: Feedback (interviews) from participants after watching the digital story
   Data analysis methods: Content analysis and critical systems heuristics
   Activity: Evaluate the impact of the digital story (i.e., to determine the effect of the digital story in creating awareness about e-waste and GIT practices).
5. Specifying learning phase
   Activity: Reflect on the previous phases of the AR cycle intervention.

Figure 5-5: F-, M-, and A-related action steps in this study

In this study, the digital story is viewed as the methodology (M) to be developed to create awareness. Perceived inefficient disposal procedures of electronic waste, is the area of concern (A). For guiding the research process, a theoretical framework was created. It contains the theoretical framework and procedures. Table 5-1 provides a summary of the study's overarching structure.

Table 5-1: A guiding framework for the study

Phases of the action research cycle / Activities	Description
Diagnosing (Chapter 6)	Describe or identify the issue: finding out from the study subjects how knowledgeable they are about GIT and e-waste procedures right now. Using exploratory semi-structured interviews, the data is acquired. Semi-structured interviews are augmented interviews with auto-photography and official documents.
Action planning and taking (Chapter 7)	Alternative course of actions is considered and create the digital story to solve the problem identified in the previous phase. Show the artefact to the participants.
Evaluation and specifying learning (Chapter 8)	Study the consequences of digital story viewing. Overreaching findings are pointed out (Gibertonia *et al.*, 2016:378; Shu, 2022:46; Susman & Evered, 1978:588). Again, learning is specified from all previous phases of the AR cycle.

5.8.1.1 Action research cycle

This study implements a single AR cycle throughout the four cases, namely university of technology (case 1, where participants are information technology technicians (ITTs)), TVET college (case 2, where participants are ITTs), TVET college (case 3, where participants are students), and university (case 4, where participants are students). The first phase begins with problem identification (diagnosing phase). The second phase is action planning (digital story). The third phase is action taking (show digital story to the participants). The fourth phase is evaluation (testing the digital story). Lastly, learning is specified from all the previous phases. In this study, the cyclic iterative nature of AR is reduced to a single cycle due to limited time, regardless of the outcome of the cycle as suggested by Shu (2022:48). Theoretically, AR will never come to an end because social concerns have a dynamic structure in which new problems are always emerging. While the intervention may therefore resolve some issues, new ones may arise and require further interventions (Tekin & Kotaman, 2013:88).

5.8.1.2 The diagnostic phase

When it is discovered that the participants' levels of knowledge regarding e-waste and GIT practices are poor, the study's continuance is warranted. The procedure for the diagnostic phase is described in the following discussion:

5.8.1.2.1 The diagnostic phase interview guide

The diagnosis of the issue in this study is guided by the following queries:

- What do the phrases e-waste and GIT mean to you?
- How does e-waste affect the environment and human health?
- Which e-waste disposal techniques do you believe to be environmentally friendly?
- Who gains from GIT, and in what ways?
- What should your organisation do with outdated IT equipment, regardless of how well it still functions?
- What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation?

5.8.1.2.2 Techniques for gathering data

Semi-structured interviews gather the data for the study. For investigations when the researcher is aware of the results he/she is seeking, semi-structured interviews are appropriate (Busetto, Wick & Gumbinger, 2020:3; Fylan, 2005:65). The interviews are augmented with the auto-photography method and official document analysis (Glaw *et al.*, 2017:1; Morgan, 2022:64).

5.8.1.2.3 Diagnostic phase data analysis

The researcher created themes using qualitative content analysis (Downe-Wambolt, 1992:314; Erlingsson & Brysiewicz, 2017:94). The researcher employed both Erlingsson and Saldaña's approaches to generate themes and categories from transcribed scripts in order to increase abstraction of raw data (Erlingsson & Brysiewicz, 2017:97; Saldaña, 2009:8). Software called ATLAS.ti is used to aid in the coding process. Krippendorff (2004:18) defined content analysis as a method to draw verifiable conclusions about contexts of usage from texts (or other significant material) to relate results to the context from which they were derived.

Content analysis can be defined as:

> *"a research method that provides a systematic and objective means to make valid inferences from verbal, visual, or written data in order to describe and quantify specific phenomena" (Downe-Wambolt, 1992:314).*

Krippendorff (2004:18) states that the researcher also uses quantitative content analysis to enhance the understanding of the data. Quantitative content analysis effects are depicted in a format that resembles a table. The activity flow throughout the diagnostic phase of this AR investigation is depicted in Table 5-2**.**

Table 5-2: The activities in the diagnosing phase

Phase of action research	Activities to take place
Diagnostic	Find out from the study participants their initial degree of awareness of waste generated by electronic equipment and practices of GIT. Semi-structured interviews are used for data collection (DeJonckheere & Vaughn, 2019:1; Fylan, 2005:65). Interviews are taped so that verbatim transcripts may be produced (Jamshed, 2014:87; McGrath, Palmgren & Liljedahl, 2019:1004). Auto-photography and institutional documents aide the interviews for triangulation (Noble & Heale, 2019:67). Themes are generated using qualitative content analysis and the process is systematically assisted with ATLAS.ti software (Bengtsson, 2016:9; Saldaña, 2009:8; Soratto *et al.*, 2020:2). Secondly, quantitative content analysis is used to enrich data presentation. The findings of quantitative content analysis are presented in a tabular format.

Analyse the participant-taken photos using ATLAS.ti software to aid in the content analysis process. Words cannot convey the richness and detail that photographs can convey (Glaw *et al.*, 2017:1; Guest, Namey & Mitchell, 2013:239).

5.8.1.3 The action planning phase

The artefact is developed in the action planning phase. Digital storytelling provides *"a platform for social change, as change can only happen when we think of new ways to see and envision the world"* (Khebbaz, 2016:10). The DSR principles are incorporated in the development of the artefact (digital story). The approach of Kajder and others is followed in creating the digital story (Kajder *et al.*, 2005:40; Yamac & Ulusoy, 2016). In addition to the method, the researcher incorporates story mapping (Ohler, 2006:45). The digital story must be mapped because it helps to create stories with depth (Laina & Marlina, 2018:266; Ohler, 2006:45). Table 5-3 shows the flow of activities that occur in this step of this AR research called action planning.

Table 5-3: Activities in the action planning phase

Phase of action research	Activities to take place
Action planning	Take into account a different strategy to address the issue found during the diagnostic step (Gibertonia *et al.*, 2016:377; Shu, 2022; Susman & Evered, 1978:588). Determine the strategy for creating the digital story. Follow DSR principles to develop the digital story (Aburamadan & Trillo, 2020:218). Create the digital story using DSR principles, story map by Ohler, and the approach suggested by Kajder and others (Kajder *et al.*, 2005:40; Laina & Marlina, 2018:266; Ohler, 2006:45). Use one drive that serves as a means for the digital story to be shown to the participants.

The DSR pillars are applied to the digital narrative creation. Researchers choose DSR because other paradigms (i.e. positivist, critical and interpretivist) do not design, develop or build new artefacts (Venable *et al.*, 2016:76). The design science research steps used are awareness of the problem, suggestion, development, evaluation and conclusion (Aburamadan & Trillo, 2020:218). During problem awareness, the output is a suggestion for the new research work. Suggestion is a significant creative stage where new performance functionality is visualised, considering an innovative design of new or existing components. In the development step or stage, the artefact is designed and implemented. The evaluation stage helps with the evaluation of the artefact according to certain criteria that are understood. Finally, the conclusion stage leads to the end of the research work and very often the results are satisfactory (Achampong & Dzidonu, 2017:2).

5.8.1.4 The action-taking phase

In this phase, the digital story is shown to the participants and data is gathered for the evaluation phase. As mentioned by Robin (2016:22), stories are meant to be shared and heard. One drive is used as a medium to serve this purpose. The activity flow for this AR study's action-taking stage is depicted in Table 5-4**.**

Table 5-4: The activities in the action-taking phase

Phase of action research	Activities to take place
Action taking	Participants who took part in the diagnostic stage are recruited to view the digital story. Interview participants again after watching the story (data collected to use in the evaluation stage). The ethical considerations are upheld (ANNEXURE C).

5.8.1.5 The evaluation phase

The interview guide questions are mapped into the four CSH categories (Reynolds, 2007:101; Zawahri, 2022:9). Each CSH question is asked in the 'is' mode to describe what as of now exists, and is repeated in the ought to mode to describe what (in each stakeholder's view) it is desired to be (Dehghan Nayeri, Khazaei & Alinasab Imani, 2018:492; Wing, 2016:68). Altogether there are twenty-four questions for CSH. Critical systems heuristics is planned as a set of questions to distinguish the boundaries of a framework. Boundaries do not need to be physical; they can be contrasts of perspective, experience, assumptions, or culture. Recognising where stakeholders fall (outside or inside the system of concern) helps with the identification of the boundary (Nicholas *et al.*, 2019:357; Wing, 2016:68). The boundary can be identified either through boundary reflection or boundary discourse (Wing, 2016:69).

> *"through boundary reflection we can achieve a new quality of professional self-reflection and in boundary discourse, a new quality of communication in and about professional interventions" (Ulrich & Reynolds, 2010:265).*

Content analysis and CSH will be used to analyse and evaluate the participants' responses after watching the digital story (Eelderink, Vervoort & van Laerhoven, 2020:4; Reynolds, 2007:101). Table 5-5 shows the mapped interview questions into the four CSH sources of influence.

Table 5-5: Interview questions mapping (Reynolds, 2007:101)

Categories of CSH / Questions for the interview	Interview questions
Motivation	Who gains from GIT, and in what ways?
Control	What should your organisation do with outdated IT equipment, regardless of how well it still functions?
Expertise	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a productive GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?
Legitimation	How does e-waste affect the biosphere and humans? Which e-waste disposal techniques do you believe to be environmentally friendly?

5.8.1.6 Motivation for mapping interview questions

When developing and evaluating any relevant human action system, boundaries are socially built. (Córdoba-Pachón, 2020:3; Reynolds, 2007:101). Boundary judgements include essential elements of every intentional system of interest (Prus *et al.*, 2017:2; Reynolds, 2007:105). The responses to CSH questions spark in-depth reflection and conversation about many elements of situational change. The actions that take place during the assessment phase of this AR research are depicted Figure 5-6 **.**

Evaluation	Map interview guide questions into CSH sources of influence. Interview the parrticipants who watched the digital story. Analyse the data and evaluate the data. (qualitative analysis and CSH sources of influence as instruments for analysis).

Figure 5-6: The activities in the evaluation phase

5.8.1.7 The specifying learning phase

The researcher will determine what has transpired because of the intervention at this step (Santos, Afonso, Piovani & Ávila, 2019:5; Wieringa & Moralı, 2012). The activity flow for the phase of defining learning is shown in Figure 5-7.

Specifying learning	Specify learning from all previous phases and identify broad conclusions as a result of individuals reading a digital story (Gibertonia et al., 2016:377; Shu, 2022:48).

Figure 5-7: The activities in the specifying learning phase

5.9 Model to generate themes

The model shown in Figure 5-8 demonstrates the data analysis strategy applied in this study.

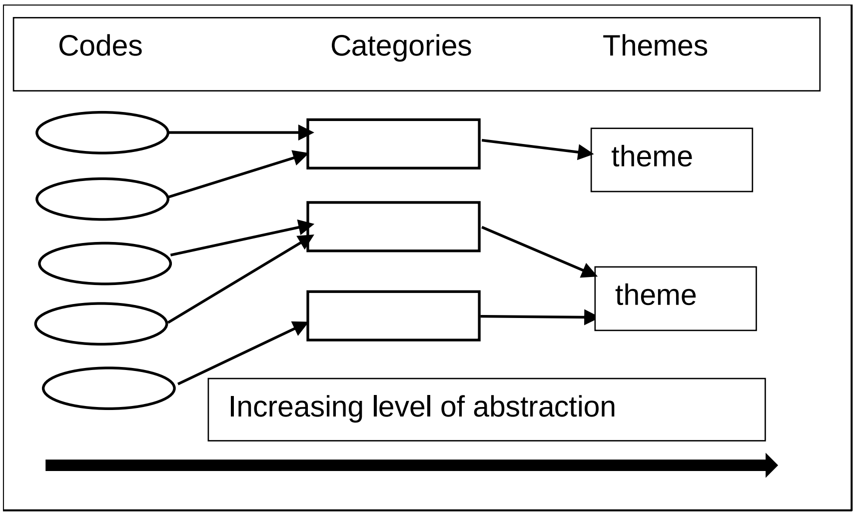


Figure 5-8: Model to produce themes for this study

Regardless of the source of the supplementary information, the content analysis approach may be used on all forms of written text. There are no set guidelines that must be adhered to (Bengtsson, 2016:10).

5.10 Rigour and evaluation of the method

The next section(s) explains on principles to validate the AR portion of the study as proposed by Heikkinen *et al.* (2012:8). The principles are historical continuity, reflexivity, dialectics, workability and ethics, and evocativeness.

5.10.1 Principle of historical continuity

Understanding the socio-historical context of any AR effort is crucial. (Heikkinen, Jong & Vanderlinde, 2016:13; Heikkinen *et al.*, 2012:8). This sort of comprehension requires the knowledge type of phronesis; the researcher is mindful of the question of how the nature of human existence or quality of life has been advanced by the practice and the research. An ethical researcher is all-round educated by the traditions of the field and the chronicled continuum of practice improvement. The principle of historical continuity additionally includes employment (Langtree, Birks & Biederman, 2019:12). A decent research report finds the logical sequence of events which are often articulated in the form of a narrative (Heikkinen *et al.*, 2016:13).

5.10.2 Principle of reflexivity

The research report explains the research materials and techniques, and the researcher is conscious of the effects of personal experience while engaging with others (Heikkinen *et al.*, 2016:13). In the execution of the study, the researcher is specific, transparent, upfront about the presumptions made, as well as the methodologies, processes, and the reasoning behind his/her selection. The researcher also acknowledges any biases and how they affect the process of working with data.

5.10.3 Principle of dialectics

The participants' varied viewpoints were respected and an attempt was made to accurately reflect them in the report (Heikkinen *et al.*, 2016:13; Heikkinen *et al.*, 2012:9). When gathering, analysing, and reporting data, the dialectic technique is employed to foster deeper understanding between the researcher and the participants. Participants' voices are reported as authentically as possible in the study report. In the study report, participant voices are presented as truthfully as feasible.

5.10.4 Principle of workability and ethics

Changes in social behaviour are brought about by the study in an ethical and critical way (Heikkinen *et al.*, 2016:13). Since humans participated in the current study, it is crucial to take ethical concerns into account both before and after the study. The researcher must keep concerns regarding secrecy and anonymity in mind before making results public. The avoidance of potential damage during the distribution of the results, as well as free and informed consent are also considered.

5.10.5 Principle of evocativeness

The study's findings compel the reader to think critically and logically, as well as emotionally (Heikkinen *et al.*, 2016:13). This research is intended to alter a person's predominate viewpoint surrounding the area of concern (study problem) and the impact on the rapidly deteriorating environment. Additionally, it wishes to inform the attendees of how GIT practices may be taken into account for appropriate e-waste disposal (Kayathri, Girija & Meena, 2018:9965; Murugesan, 2008:24).

5.11 Summary

In this chapter, all aspects of the methodology to be used in this study were discussed. The importance of the methodology in this study was to permit readers to assess the general validity and dependability of the study and to provide critical insight into two crucial aspects of the research, that is, data gathering and analysis.

The research methodology is covered in great length in this chapter. Four well-known research paradigms were presented, along with how well they fit this study. The critical social theory was the chosen paradigm. The study was aimed at empowering participants. Critical systems thinking and critical systems heuristics were explored and positioned for the investigation. The data gathering, participant selection and data analysis methods were identified and discussed. The method to analyse the data was illustrated and explained. There was also an indication of how ethical issues would be handled in this study. Rigour and validity of the results are crucial in this study. Therefore, the study identified and explained five principles that will be implemented to ensure rigour and evaluation of the method. The study involves four case studies, therefore there was an explanation of how cross-case analysis would be carried out.

The purpose in the next chapter is to identify the problem and justify the continuation of the study. This activity will be done under the diagnostic phase of the action research for the study.

CHAPTER 6 DIAGNOSING THE PROBLEM

6.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

The purpose of this chapter is to determine the participants' current awareness level of green information technology practices when dealing with e-waste. Diagnosis of low levels of awareness in green information technology practices in e-waste disposal justify continuation of the study (Gibertonia *et al.*, 2016:377; Shu, 2022:47; Susman & Evered, 1978:588).

Data is gathered from each of the four higher education institutions (four case studies). The collected data is then analysed to determine the existence of the problem from each case study. The data gathering and collecting techniques are discussed and it was shown how they were implemented in the diagnostic phase. In this chapter, how the participants were selected for the diagnostic phase is discussed. The brief history of the participants and the instances (higher education institutions) are also provided. Diagnosis of low levels of awareness in green information technology practices in electronic waste disposal justifies the continuation of the study. The similarities and differences between the four instances (cases) and how they affect the findings of the diagnostic phase of action research are highlighted.

The presentation of the reminder of the chapter is as follows: Data analysis discussion for the diagnosing phase is presented in Section 6.2. In Section 6.3 and Section 6.4, participant selection and data gathering, respectively are discussed. In Section 6.5, the diagnostic phase for the university of technology (case1) is addressed. In Section 6.6 and Section 6.7, a discussion on diagnosing phase for the Technical and Vocational Education and Training (TVET) college (case 2) and the TVET college (case 3), respectively is provided. The university (case 4) discussion on the diagnostic phase is provided in Section 6.8. In Section 6.9, the cross-case analysis of the four cases is under discussion and in Section 6.10, a summary provides the conclusion.

6.2 Analysing the data

The following data analysis strategy discussion applies to all case studies. Data is transcribed verbatim. Transcribing data is done in a private room by the researcher using the headphones to avoid the possibility of data being heard by other people or participants. During data transcription, any piece of data that could relate to the participants was removed. The study participants are referred to by alias names in verbatim quotes. To make sense of the data, the researcher read it several times. The themes were generated with the aid of Archive for Technology, Lifeworld and Everyday Language.text interpretation (ATLAS.ti) (Paulus, 2022:1). The researcher chose ATLAS.ti software, based on previous experience. Descriptive and in vivo coding are used by the researcher to code quotes. Reading the participant transcripts word-for-word allowed the researcher to deduce all the codes. ATLAS.ti software was the only piece of software employed by the researcher to aid in the data analysis; no predefined coding or classifications were used. By segmenting the data and then recombining it in different ways, the researcher categorised it. The transcripts were the source of all codes and classifications. The excerpts were taken directly from the book and seemed to capture the main ideas. Thereafter, clusters were created from the generated codes. To enhance data interpretation, the researcher also conducted quantitative content analysis in addition to qualitative content analysis (Hamad, Savundranayagam, Holmes, Kinsella & Johnson, 2016:3; Kleinheksel *et al.*, 2020:128; Krippendorff, 2004:192).

The outcomes of the quantitative content analysis are shown in a tabular format. As noted by Erlingsson and Brysiewicz (2017:94), developing themes is a reflective process, and that following the coding and classifying, one has to return to the raw data and consider the results of the initial analysis. The critical systems heuristics (CSH) framework was used to analyse the interview data collected. Critical systems heuristics supplemented the content analyses method.

6.3 Selection of the participants

For all four instances, homogenous purposive sampling was used because it simplifies analysis and minimises variation (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood, 2015:3). The participants' roles and duties within the overall institutional information and technology requirements served as the deciding factor. The participants are Information and Technology Technicians (ITTs) for case 1 and case 2. Secondly participants are identified as students for case 3 and case 4.

6.4 Gathering the data

The data was gathered using interviews and the auto-photography method. The interviews were designed by the researcher and validated by experts’ judgements from two HEIs (Sánchez-Guardiola Paredes, Aguaded Ramírez & Rodríguez-Sabiote, 2021:5). For case 1 and case 2 both interviews and photographs are used to collect data. Student participants are reluctant to take photographs; hence interviews are the only method to gather data for case 3 and case 4. Each participant agreed to take part in the study (Manti & Licari, 2018:145). The researcher’s data gathering process was guided by the ethical requirements when conducting scientific study. The researcher wanted to gather data from the official documents to allow for document analysis. During the data gathering process, the much-needed documents were not available.

A smartphone was used to record every interview. As soon as the transcripts and field notes were obtained, they were analysed for each interview. English was the language used for all of the interviews. The institution's boardroom served as the location for the interviews. Smartphones were provided to participants who were willing to take photographs. The researcher kept the photographs taken by participants in an envelope and locked them in a locker.

6.5 University of technology (case 1)

This study's university of Technology (UoT) was a public higher education school that enrols students from all provinces as well as from 25 other nations. With more than 20 000 yearly enrolments, it is one of the biggest UoTs in the country. The UoT is divided into four faculties: applied and computer sciences, engineering and technology, management sciences, and human sciences.

6.5.1 A brief history of the participants

Information technology technicians (ITTs) from the Information Technology Services (IT Services) department made up all the participants. All have been employed in the same capacity for more than a year. There were roughly 25 possible research participants in the IT Services department.

6.5.2 Themes generated (interviews)

The following themes emerged from the data analysis through content data analysis: institutional management of waste generated by electronic gadgets, existing methods for disposing of e-waste, understanding how e-waste affects the environment and public health, green information technology (GIT) advantages and recipients, challenges to implementing GIT practices, and knowledge of GIT phrases and e-waste. The themes derived are described in the next section. The **X** identifier in this study stands for participant.

6.5.2.1 Theme 1: Disposal

Human subject X5 was cited as stating, "*However, if they don't work, we throw them away—sometimes in the trash bins or leave them scattered around for service personnel to pick up*." When asked when they are picked up by service personnel and what their destination is, X1’s reply was, “*I don’t know*”. X4 answered, "*The main reason we throw things away is that we need space to store other things*." It is the right thing to do making space for other staff. However, the issue of how electronic waste is discarded remains. The responses show a lack of knowledge and understanding about GIT and e-waste. On the other hand, X1 was quoted as saying, "*I give it to a member of my family".* Donation is good provided that the equipment is in good working condition and the giver will take responsibility for the item when it is no longer in working order. Most participants went for this option to deal with their waste. Table 6-1 lists the frequency codes for electronic waste management techniques related to theme 1.

Table 6-1: Frequency codes for electronic waste management techniques.

Subject \ Participant	X1	X2	X3	X4	X5	X6	X7	Cumulative
Electronic waste may be disposed of by placing it in public garbage cans or by burying it in the ground.	0	1	1	1	1	1	1	6
E-waste (functional/non-functional) can be sold or given to a family member.	1	1	1	1	1	1	1	7
Keeping electronic waste (dwelling or location of employment)	0	1	0	1	1	1	1	5
Electronic waste should be burned.	0	0	0	0	0	1	1	2
Recycling e-waste	0	0	0	0	0	1	0	1

6.5.2.2 Theme 2: Environment and public well-being

X7 however, made a joke about wires, "*cables might trip someone, causing fall or hurt*". Indeed, unattended cables can get messy and cause harm. According to X4, e-waste does more environmental harm than it does to humans and other living matter. *"True, but not to individuals in general, rather to their surroundings"* (X4). Electronic waste is detrimental to both biosphere and humans alike (Moyen Massa & Archodoulaki, 2023:1). "*Cartridges leftovers or toner waste when inhaled will affect the lungs*", replied X6. For example, respiratory challenges, such as asthma can be caused by this waste in the long run (Parthasarathy, 2021:1). Table 6-2 list code's frequency of occurrence on the effects of electronic waste related to theme 2.

Table 6-2: Codes' frequency of occurrence on the effects of electronic waste

Subject \ Participant	X1	X2	X3	X4	X5	X6	X7	Cumulative
The environment and human health are negatively impacted by computer monitors, wires, cartridges.	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**6**

6.5.2.3 Theme 3: Advantages and recipients

Participant X1 thinks that businesses that market and produce GIT goods are the GIT's real winners. "*People start to adore and purchase their environmentally friendly items when they publicize them." (*X1). However, it should be stressed at this point that people will only be interested in an eco-friendly environment when they are knowledgeable about the benefits of green products. X5 reportedly said, "*I'm sorry, not familiar with the phrases e-waste and GIT*". This is proof that the participants need to be educated on the issue raised by the study. *"The community will gain from the money being made."* (X3). The community will benefit optimally if disposal is performed effectively (Ghulam & Abushammala, 2023:2). The benefits will include improved well-being and monetary gain from commodities extracted from waste. The following participants (X4, 5 and 7) were uncertain about the beneficiaries. Table 6-3 shows the code frequencies for benefits and users of green information technology related to theme 3.

Table 6-3: Code frequencies for benefits and users of green information technology

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	Cumulative
Recipients	1	1	1	0	0	1	0	4
Advantages	1	1	1	0	0	1	0	4

6.5.2.4 Theme 4: Institutional control

"No, there hasn't been a similar action while I've worked here. Throwing things out helps us clear the storage," replied X2. The remarks of X2 indicate that the institution has not started programmes geared to effective management of e-waste. Moreover, an ineffective disposal method is still relied upon by the participant. All the participants attest that effective plans of e-waste management are not in place yet. *"Green information technology is not pursued",* (X7). Table 6-4 list frequency codes on institutional control of electronic waste related to theme 4.

Table 6-4: Frequency codes on institutional control of electronic waste

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	Cumulative
Ineffectively run	0	0	1	1	1	1	1	5
Moderately handled	0	1	0	0	0	0	0	1
Run effectively	0	0	0	0	0	0	0	0
Undecided	1	0	0	0	0	0	0	1

6.5.2.5 Theme 5: Implementation obstacles

"*Three years ago, purchase was made of new equipment, since then are lying and gathering dust. Line managers are not updating us what to do with them*", claims X1. It is often recorded that people at the top have a hand in resisting some of the changes in the organisation. This is a typical example of managers who are able to prevent change from taking place (Ara, 2018:44). X7 moved on to say, "*They're uneducated in e-waste challenges, in my opinion. We need a system that is backed by the top management if green information technology is to become a reality".* The two issues that surpass non-implementation of GIT were financial matters and insufficient knowledge and understanding about the effects of this waste on the biosphere and humans (Sabeel, 2017:194). Table 6-5 shows code incidence rates on implementation issues related to theme 5.

Table 6-5: Code incidence rates on implementation issues

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	Cumulative
Knowledge and understanding	1	0	0	0	1	0	0	2
Unwillingness by managers	1	0	0	1	1	1	1	5
Monetary injection	0	0	1	0	0	0	0	1

6.5.2.6 Theme 6: Terminology

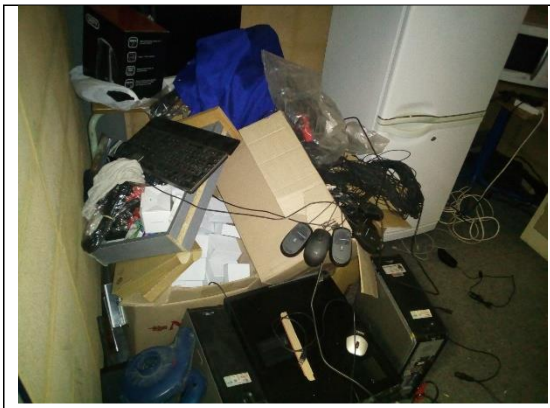
"*Green information technology in my opinion has to do with reducing the amount of paper used. We may utilize digital copies rather than hard copies*", replied X1. X7 remarked that "*Green information technology is also about power saving*". Green information technology encompasses much more than just saving paper and energy. Electricity is only a subset of energy. Green information technology has to do with the effective disposal, use, manufacturing and design of IT equipment (Bokolo, 2020:2). X1 continued to say, "*Electronic waste is recycling of unwanted machines at the workplace*". P6 argued, "*e-waste is . . . about outdated or unwanted computer components*." Indeed, e-waste is abandoned electronic devices irrespective of their functionality (Corwin, 2017:17). Moreover, it has its own advantages and disadvantages depending on how it is handled during disposal processes. Table 6-6 list the code's frequency on comprehension of the terminology related to theme 6.

Table 6-6: Code's frequency on comprehension of the terminology

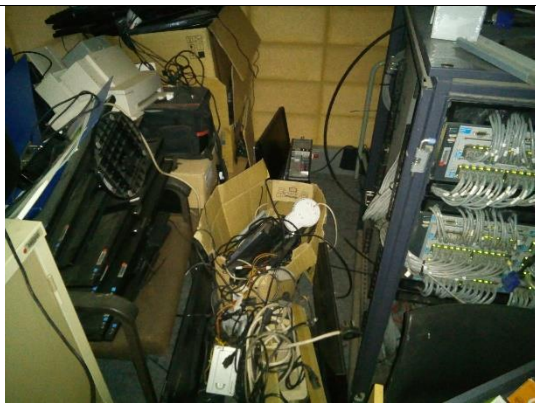
Subject \ Participant	X1	X2	X3	X4	X5	X6	X7	Cumulative
Familiar with GIT and e-waste	1	1	1	0	0	1	1	5

6.5.3 Themes generated (auto-photography)

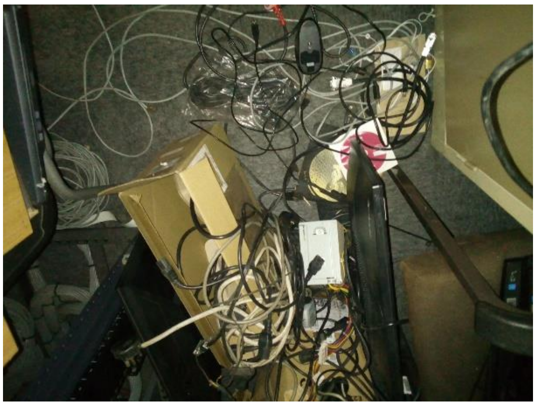
Below are photos taken by the participants in this institution (case 1). They were analysed and disposal was the theme generated. The pictures were discussed between the researcher and photographers (study subjects). Photos taken by participants in this institution are shown in Figure 6-1.



(a) Cables, Mice, computer boxes



(b) Printer, cables, monitors



(c) Cables, monitor, computer boxes

(d) Computer monitors

(e) Computer boxes

Figure 6-1: Sample of the photographs taken by the participants (case 1)

6.5.3.1 Theme 1: Disposal

X1 said, "*pictures I took were still in the same place last year when I completed my diploma. That time was before employed as information technology technician*". X2 added, "*this is what I believe* *is waste, because they are abandoned for long duration*". "*That is all I am aware of concerning the circumstances here",* X4 remarked. Faculty members and staff generated this waste. Seemingly, both staff and students were happy with the situation, as no movement is taking place with these items. The literature noted that in HEIs, most e-waste is kept in laboratories (Borthakur & Govind, 2017:227; Kitila, 2015:319). The pictures attest to this claim.

6.5.4 Mapping CSH (questions)

Table 6-7 shows a summary of participants' responses during the diagnosing phase of university of technology (case 1).

Table 6-7: Diagnosing phase responses (diagnosing)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"People".* • *"Green information technology reduces carbon footprint ".*	• *"They should donate such equipment to their employees or resale at very low cost".*	• *"I think they are not aware because I never heard students or other workers talk about it".* • *"Electronic waste is every computer component that is not wanted ".*	• *"Do not know of any, as we speak. Maybe I will have to read".* • *"Give to family members if is working otherwise put into trash".* • *"Giving someone is good, and taking to the bin is good too for the environment".*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Employees".* • *"Improved well-being of employees ".*	• "They should donate an unused equipment to the community *".*	• *"Surely, I cannot give you the answer. I don't know really".* • *"Electronic waste is throwing away or discarding of electronic devices whereas GIT refers to a process of disposing computers*	• *"I once read that e-waste contains toxic components to health".* • *"Put e-waste into rubbish bin or throw way".*

				related equipment in a green way ".	• *"Maybe throwing away can be bad, but putting into rubbish bin is ok".*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Companies with e-waste".* • *"Because they can turn their e-waste into cash".*	• *"Give it to scrap yard owners or donate to us if is working ".*	• *"I think is not practice because of financial constraints. Here we have many challenges such as lack of resources to deal with first".* • *"I think e-waste is anything you don't want anymore and with GIT anything good for the earth".*	• *"Printer cartridges contain powders that are dangerous to health when inhaled or consumed".* • *"Throw away into rubbish bin".* • *"I think this is spring cleaning similar to what we were doing in our school days".*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases "*e-waste*" and "*GIT*" mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"I am not sure sir; can you help?".* • *"Since I am not sure what is GIT, but I will try. Whoever benefit makes money out of it. Today is all about money nothing else ".*	• *"Maybe they can send it together with municipal waste to be taken to landfills ".*	• *"Remember, I am not sure what is GIT, so how could I possibly answer this?"* • *"For me waste is something not needed, with e-waste not sure, GIT because it has the word green, I think is what is good for us ".*	• *"I learnt from magazine that it can contaminate water and soil".* • *"Keep in the office or home with prospects of future use".* • *"I keep it because it may be useful in the future".*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Frankly I don't know who benefits".* • *"I think whoever benefit make money out of GIT"*	• *"They should sell unwanted IT equipment to collectors or recyclers make extra profit or cash ".*	• *"I think is not considered as important because since I join here there have been no initiatives that advocate GIT".* • *"I think e-waste is anything you don't need and with GIT I am not sure ".*	• *"It makes people lose their mind, check what happen to drug addicts who steal people flat screen televisions, they break screens to get the powder and snuff it to get high".* • *"Possible ways to get rid of e-waste includes rubbish bins so municipality can collect it".* • *"Sending to municipality will keep environment clean as they deal with all sorts of waste".*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"I think the businesses or organisations".* • *"Savings on electricity costs to organisations ".*	• *"They sell them or donate to us as employees ".*	• *"It is not practiced the way it should because e-waste is stored in rooms. You can even find some computer left and gathered with dust in students' laboratories".* • *"Electronic waste is the unwanted electronic devices. Green information technology is handling of electronic equipment*	• *"Whenever you pass the landfill, you can smell toxic fumes from burning e-waste. I believe those fumes in the long run they can cause illnesses".* • *"Keep home just in case you may need it or throw it away if not working".* • *"Keeping home has got nothing to do with polluting the environment.*

			in a way not to damage the environment ".	*You put it in a clean closet or place".*
Source of influence **X7**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions	Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?
Responses	• *"I think no one benefit. I have not heard of one".* • *"Similarly, I won't have answer because previously I mentioned that no one benefit ".*	• *"I think the department of higher education should direct us what to do with unwanted IT devices ".*	• *"I am not sure. There is no information in the public from my organisation on what do to with e-waste. there is e-waste lying around in the offices and laboratories".* • *"Electronic waste is any of electronic or electronic and not usable, whereas GIT is ways to use power efficiently ".*	• *"I think fumes from e-waste plastics can pollute the air we breathe. Some powders from other components can kill if consumed".* • *"Sell to 'scrap pickers or e-waste collectors in the neighbourhood".* • *"Selling to the next person does not have negative effects to the environment".*

The replies given by the participants in relation to the four CSH sources of influence are subsequently addressed.

6.5.4.1 Motivation

Question(s): Who gains from GIT, and in what ways?

X4 said that *"I am not sure sir; can you help"* when asked who benefits from GIT. X7 said, *"I think no one benefit . . . staff, students, and facility are not aware of on how to manage e-waste properly"* (Maphosa, 2021:563). However, X3 said that "*Companies*" gain from GIT. X3 continued by stating that businesses will profit because "*They can turn their waste for cash*". Green information technology encompasses more than only disposal (Sarkis, Koo & Watson, 2013:696). Who the GIT beneficiaries are, was a question that X4, X5, and X3 could not accurately answer.

6.5.4.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

"*Give it to the scrap yard*", X3 advised. "*Perhaps they can send it along with municipal waste to be taken to landfills*", X4 said. Recycling precious metals from e-waste reduces dependency on raw resources used to produce new goods (Arokiaraj, Yamuna & Ramanarayan, 2019:38; Namias, 2013:1). The majority of dangerous recycling is done by scrapyards (Burns *et al.*, 2019:1; Perkins, Brune Drisse, Nxele & Sly, 2014:290). Comments from X3 and X4 imply a lack of knowledge regarding the effects of e-waste on the environment and health. "*The higher education department should provide us instructions on what to do with unused IT gadgets"* (X7), on the other hand, remarked. For organisations to successfully execute sustainable projects, stakeholder participation is crucial (Dale, Kline, Parish & Eichler, 2019:1211).

6.5.4.3 Expertise

Question(s): What steps does your company take to implement "*GIT*"? If not, what obstacles stand in the way for successful GIT implementation? What do phrases e-waste and GIT mean to you?

"*E-waste is scattered around the offices and laboratories*" according to X7.

P5 stated:

> *"I believe is not seen as significant because there have been no measures to support GIT since I joined here. You could still find some computers that have been abandoned and are coated in dust in student laboratories".*

X3 remarked:

> *"I think is not practice because of financial constraints. Here we have many challenges such as lack of resources to deal with first. I think e-waste is anything you don't want anymore and with GIT anything good for the earth".*

According to Msengi, Doe, Wilson, Fowler, Wigginton, Olorunyomi, Banks and Morel (2019:7), HEI's capacity to implement institution-wide sustainability efforts is hampered by budgetary constraints. *"I think they are not aware. . ."* (X1). A few obstacles preventing HEIs from implementing GIT include unwillingness, early financial expenses, a lack of training, improper procurement procedures, and a lack of awareness (Dayaday & Galleto, 2022:537; Sabeel, 2017:194; Suryawanshi & Narkhede, 2015:702).

6.5.4.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which 'e-waste disposal techniques do you believe to be environmentally friendly?

Aside from X1, all hold rudimentary understanding of how e-waste impacts the biosphere and well-being. "*. . .I will read*", remarked X1. "*Throwing away can be bad, . . . rubbish container is ok*" (X2). Putting e-waste into the bin is not a good idea, as rubbish from the bin is collected by the municipality who themselves struggle with discarding general waste effectively. The municipality relies on landfilling know-how to handle dumping sites (Abubakar, Maniruzzaman, Dano, AlShihri, AlShammari, Ahmed, Al-Gehlani & Alrawaf, 2022:6). The issues raised here are synonymous with previous cases (instances). They all point to the fact that participants really need education in the subject of the study. Containing waste of this nature in a location, such as a house or office is discouraged.

6.6 TVET college (case 2)

The institution was established in 2002 as a result of the amalgamation of three colleges, and it is one of the eight colleges in the province of Gauteng (CoursesEye, 2019:1). 27 businesses have joined forces with the university to form a relationship, which has allowed the college to position students for the following opportunities: apprenticeships, internships, and learnerships (Department of Higher Education and Training, 2017:43).

6.6.1 A brief history of the participants

Six information technology technicians (ITTs) who are in charge of the complete network and other IT services needed by the entire institution took part. Making sure the college's information technology resources run efficiently is part of the ITT's responsibility. The duties include responding to IT-related questions from the school management team, and teaching staff, and students in computer labs.

6.6.2 Themes generated (interviews)

Themes that emerged from the data analysis included disposal habits, awareness of the impact on humans and the biosphere brought about by e-waste, advantages and recipients of GIT, institutional handling of electronic waste, difficulties implementing GIT, and comprehension of the phrases e-waste and GIT.

6.6.2.1 Theme 1: Disposal routine

Each participant places his/her unneeded gear in a trash can. X1 stated, "*I dispose of the majority in the dustbins*." X2 stated, "*. . . in our office trash cans, like computer mice and hard drives*." Landfills are manifestations of rubbish containers from municipal collectors (Abdel-Shafy & Mansour, 2018:1278). There was no mention of recycling it or burning the e-waste. Electronic waste storage in company storerooms came in second on the list of recommended disposal methods. X4 stated, "*Our storerooms are overflowing with obsolete computer equipment.*" When asked why they are kept in the storerooms, X6 said, *“This has been happening before we came to work here”*. Table 6-8 shows frequency codes for the present waste disposal habits related to theme 1.

Table 6-8: Frequency codes for the present waste disposal habits

Subject \ Participant	X1	X2	X3	X4	X5	X6	Cumulative
Put electronic waste in the municipality's trash cans or bury it in the ground.	1	1	1	1	1	1	6
Give e-waste to a relative, a friend.	0	0	0	0	1	0	2
Keep at dwelling places, the office's storage areas.	1	1	0	1	0	1	4
e-Waste should be burned.	0	0	0	0	0	0	0
e-Waste should be recycled.	0	0	0	0	0	0	0

6.6.2.2 Theme 2: Effects on humans and the biosphere

"*Cartridge leftovers are not good for digestion. They are toxic*", warned X3 in his response. X6 continued, "*toddlers should not be allowed to play with monitors as are toxic"* Perkins *et al.*

(2014:291) warn that toddlers have the tendency to put everything with which they come into contact into their mouths. This is human behaviour. The issue with toner leftovers resurfaced again, as was the issue in the previous case (instance). Children cannot be compared with adults as they are still in the developmental stage, which makes them more prone to harm (Lebbie *et al.*, 2021:3). Table 6-9 shows code incidence rates for comprehension about electronic waste impact related to theme 2.

Table 6-9: Code incidence rates for comprehension about electronic waste impact

Participant / Content	X1	X2	X3	X4	X5	X6	Cumulative
The use of monitors and ink containers has an adverse effect on the biosphere and human well-being.	0	0	1	0	1	1	3

6.6.2.3 Theme 3: Benefits and beneficiaries

"Beneficiaries are businesses that generate GIT goods", according to X3. X6 asserted that "*Everyone is the beneficiary*," whereas X5 asserted that "*The surroundings will benefit*." X1 and X2 are unaware of the recipients' identities and how they benefit. "*People would favour ecologically friendly items*", P3 recommended. X3's comments are underscored by Esmailpour and Rajabi (2016:32). Table 6-10 list code incidence rates for the advantages and users related to theme 3.

Table 6-10: Code incidence rates for the advantages and users

Participant / Subject	X1	X2	X3	X4	X5	X6	Cumulative
Recipients	0	0	1	0	1	1	3
Gains	0	0	1	0	1	1	3

6.6.2.4 Theme 4: Institutional management

The statement "*we see e-waste all over the campus, regardless of the component size*" was made by X6. Most e-waste is left idle due to insufficient knowledge of how to deal with it properly (Borthakur & Govind, 2017:226; Gupta, 2011:78). X5 stated, "*When equipment only needs a few parts replaced, they are encouraged to purchase new products*". "*No one promotes the buying of*

GIT goods", P5 continued. Table 6-11 shows code incidents rates about organisational treatment of electronic waste related to theme 4.

Table 6-11: Code incidents rates about organisational treatment of electronic waste

Participant / Subject	X1	X2	X3	X4	X5	X6	Cumulative
Shabby management	0	0	1	1	1	1	4
Reasonable management	0	0	0	0	0	0	0
Effectiveness	0	0	0	0	0	0	0
Uncertain	1	1	0	0	0	0	2

6.6.2.5 Theme 5: Green information technology challenges

Participant X6 stated "*becoming unaware is the barrier to implement*". The second most favoured reason to practice environmentally friendly initiatives curbing e-waste challenges was people's opposition. The most favoured was insufficient understanding when it comes to e-waste. *". . . not willing to change",* (X3). X3's opinion is supported by studies (Talwar, Talwar, Kaur & Dhir, 2020:286). Table 6-12 list code incidence rates for issues with implementation related to theme 5.

Table 6-12: Code incidence rates for issues with implementation.

Participant / Subject	X1	X2	X3	X4	X5	X6	Cumulative
Being aware	1	1	1	1	1	1	6
Rejection to willingness	0	0	1	1	1	1	4
Monetary difficulties	0	1	1	0	1	0	3

6.6.2.6 Theme 6: Terminology

X1 said, "*Green information technology—I have no idea what that even means*." When asked what electronic waste is, X1 responded, "*The same as GIT, I'm not really sure*". Participants (X4 and X5) felt that electricity savings are due to GIT. It is evident that more education is needed. Table 6-13 shows code incidence rates comprehending terminology related to theme 6.

Table 6-13: Code incidence rates comprehending terminology

Participant / Subject	X1	X2	X3	X4	X5	X6	Cumulative
Familiar with GIT and e-waste	0	0	1	1	1	1	4

6.6.3 Theme generated (auto-photography)

Photos were taken by some participants who identify with what they are able to relate to electronic waste in their institution. The photos taken by participants in this institution are shown in Figure 6-2 below. The themes that were generated from analysing the photographs are next:

6.6.4 Theme 1: Electronic equipment disposal

"*E-waste kept in this location years*", X3. X4 said:

> *"Photos will be evidence of the existing waste that is pilling. I do not think there is a strategy about accumulating e-waste. it is clear taking from photos that electronic trash does exit in this institution."*

X3 claimed that "*it has been a while these unwanted gadgets being abandoned."* Managers rarely visit operation sites, such as laboratories, and as a result, operational staff members are responsible for reporting and taking initiatives to solve imminent challenges, such as e-waste. On other side of the coin, it makes it easy to believe that they too have a paucity of knowledge and understanding when it comes to issues of sustainable computing and the environment. Literature has demonstrated that the decision maker has a role to play in effective waste disposal initiatives.

(a) Monitors and computer boxes

(b) Cables

(c) Monitors and keyboards

(d) Computer boxes

Figure 6-2: Sample of the photographs taken by the participants (case 2)

Table 6-14 shows a summary of participants' responses during the diagnosing phase of TVET (case 2).

6.6.5 Mapping CSH (questions)

Table 6-14 shows a summary of participants' responses during the diagnosing phase of TVET (case 2).

Table 6-14: Diagnosing phase responses (diagnosing)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Manufacturers of GIT I think".* • *"Just saying because I not sure exactly what is GIT ".*	• *"I am not sure really".*	• *"I cannot comment due to lack of knowing what GIT is?"* • *"Electronic waste and GIT are new terms for me. However, I sometimes see topics on those but ignore to read ".*	• *"I think they hold no good news to environment and people's health since are referred to as waste".* • *"I think keep your device home if is functional or hand to a family member".* • *"If it is in family your show that your care, and if you keep it home you can use it if the current you are using get lost or misplaced ".*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases "e-waste" and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"I am not sure, because GIT is a new terminology at all".* • *"I assume it saves us computer energy ".*	• *"Maybe, I don't know".*	• *"Maybe I am oblivious, but nothing has changed since before joining this institution".* • *"Electronic waste is same as waste that nobody wants and GIT it must be something to do with green computers that are said to save electricity".*	• *"I think they pollute environment and make people sick".* • *"I will give to family or relative".* • *"Family comes first".*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"The companies that produces GIT products".* • *"They will make huge profits ".*	• *"Ask people who know about IT ".*	• *"I think poorly because there have been no GIT initiatives".* • *"Electronic waste are computers that are not needed, and GIT is about saving electricity ".*	• *"The fumes can cause respiratory illnesses".* • *"Best solution is to put it into trash bin".* • *"Municipalities knows how to work with waste; therefore, they know safe methods to dispose e-waste?"*
Sources of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment".* • *"Helps us not to pollute the earth ."*	• *"They should consult with their IT departments on what to do with IT devices not wanted ".*	• *"Poorly because no one is talking about it".* • *"Electronic waste are devices of IT not wanted whereas GIT is ways to save electricity and printing papers ".*	• *"Not sure, since battling with the term e-waste".* • *"I think the government knows and can direct the good practice".* • *"Government has control over the country, so they can implement what is good for all of us".*
Sources of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"I think the government is the one that benefit".* • *"They will make money from tax due by companies that produces computers that saves electricity".*	• *"I think they should donate to charity ".*	• *"Not enough, you will always see computer components and cartridges around the campus".* • *"Ah simple, GIT is all about saving paper and electricity. Electronic waste is making sure unwanted computers are put safely away ".*	• *"I read that e-waste can kill and destroy environment".* • *"I think recycling is the way to go".* • *"Recycling reduces waste, therefore there will be minimal impact of e-waste to health and environment".*
Sources of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses	• *"People who use GIT products".* • *"We were told that GIT products save you and businesses electricity ".*	• *"Sell to employees at very low prices or take for recycling the dysfunctional items ".*	• *"You always see computers from students' laboratories running even over the weekends. That is the sign that is not practised good enough".* • *"Electronic waste are devices that uses electricity and unwanted and GIT is about disposing them safely".*	• *"Pollute earth".* • *"I think the best is to burn it"".* • *"Yes, when you stop producing more and burn old ones you reduce the impact of waste already in the market ".*

The participants' responses, as they relate to the four CSH sources of influence, are discussed next.

6.6.5.1 Motivation

Question(s): Who gains from GIT, and in what ways?

"*I am not sure, because GIT is a brand-new terminology at all,"* X2 responded. Green information technology has been in existence for a while. Ignorance or insufficient knowledge can be held accountable for people not being familiar with it. According to X2, "*Green information technology saves electricity*". Electricity is part of energy. Energy is a broad subject. Green information technology is not limited to energy savings but does more than that. For example, it encourages green disposal manufacturing and designs and disposal to mention a few.

6.6.5.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

"Ask people who have knowledge about IT" replied X3. It is apparent that X3 was uneasy with the question, a clear indication of the low level of understanding of what effective disposal is all about. X6 said, "*Sell to employees at very low prices or take for recycling the dysfunctional items*." X6 is right. Recycling conserves virgin materials. On the other hand, selling extends the usage of the product. In turn, this strategy also saves unprocessed resources.

6.6.5.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?

X1 responded, "*I cannot remark as I am unfamiliar with GIT, regarding how GIT is utilized at the university*." X4 stated, "*There have been no GIT initiatives, which makes me think poorly.*" From X4's perspective it is clear nothing is happening about initiatives that are about sustainability in the context of the study. Again, X1's response ignites the feeling of low understanding about what GIT can offer. More education is needed.

6.6.5.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

X3 said, *“The fumes can cause respiratory illnesses”*. Deteriorating health has long been attributed to the fierce heat of e-waste being burnt. Electronic waste mostly consists of toxic substances (Chen, Li, Yang, Hou , Liu & Zhang, 2019:2). X2 said that “*I think they pollute environment and make people sick*”. Electronic waste does not only pollute the biosphere, but makes the problem worse by contaminating the source of food for both animals and humans (Maphosa & Maphosa, 2020:4). P5 remarked, *“I think recycling is the way to go.”* Indeed, official recycling is safe. Recycling that is unofficial is discouraged, as it is associated with damage to the biosphere.

6.7 TVET college (case 3)

This higher education system includes technical vocational education and training institutions, which accepts students who have completed their schooling up to at least grade nine. To get practical experience, university graduates can enrol in courses at TVET colleges as well. British Annual International Skills Relationships Seminars are one of the institutions' notable international relationships. These lectures alternate between major cities throughout the world and the United Kingdom. Through international cooperation, the seminars seek to solve the issues of a skills shortage.

6.7.1 A brief history of the participants

Fourteen students voluntarily took part in this study as participants. For the National Certificate (Vocational) (NC(V)) in computer technology, the students were enrolled in classes. At levels two, three, and four of the National Qualification Framework, the NCV qualification is available (Department of Higher Education and Training, 2019:60).

6.7.2 Themes generated (interviews)

The themes generated were disposal, curriculum, awareness and green information initiatives.

6.7.2.1 Theme 1: Disposal

Participant X1 stated, "*I throw away my broken electronic devices in municipal trash bins*." According to X3, “*unused IT equipment is maintained at home or handed to a family member if it is functional*”. Adding this type of waste to general municipal waste is not an ideal way of disposal. Doing so, makes it possible for the toxic materials to seep into the ground. The literature has pointed out that most of the municipal waste is dumped in landfill sites (Naik & Satya Eswari, 2022:4). Donating the outdated equipment is a good idea provided that the gadget is in working condition (Abul Kalam Azad, Islam and Ismail Hossin (2017:1123). Keeping unused equipment at home is not an effective method of dealing with the e-waste challenge (Shevchenko *et al.* (2019:11). Table 6-15 shows code incidence rates for present electronic waste operations related to theme 1.

Table 6-15: Code incidence rates for present electronic waste operations

Subject \ Participant	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Burn/discard	1	0	1	1	1	0	1	0	1	0	1	0	0	0	6
Sell/give	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
Save at house, business, or spare rooms.	0	0	1	0	0	0	0	1	0	1	0	1	1	1	6

6.7.2.2 Theme 2: Curriculum

X2 said that "*what is GIT or e-waste is not taught in lecture halls."* X1 thought that a module should be taught in the curriculum that covered e-waste education. "*I would be able to respond confidently if it were a part of our curriculum, the person said.*" The researcher believes in the saying that it is best to teach someone to catch a fish rather than to give that person a fish. In this context, if sustainability with regard to the context of the study is taught in institutions, students will grow into future leaders knowing what is right to preserve the environment for tomorrow's generation (de Vega, Ojeda-Benitez & Ramirez-Barreto, 2008:522; Nganji & Brayshaw, 2010:1). Table 6-16 list frequency codes for instruction on environmental concerns related to theme 2.

Table 6-16: Frequency codes for instruction on environmental concerns

Content \ Participant	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Sufficient	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Insufficient	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14

6.7.2.3 Theme 3: Green information initiatives

"*Nobody is talking about environmental concerns like e-waste*", according to X1. "*Even during SRC meetings, environmental issues are never brought up or discussed*", (X7). The responses of the participants raise the alarm about the lack of the institution rising to the challenge to prioritise environmental issues, such as electronic waste. "*There isn't a campus-wide e-waste management effort*" (X3). For such initiatives to get off the ground, takes effort and willingness from all stakeholders (Tangwanichagapong *et al.*, 2017:203). Table 6-17 shows code incidence rates on pro-environment initiatives related to theme 3.

Table 6-17: Code incidence rates on pro-environment initiatives

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Efforts present	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Efforts are not present.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14

6.7.2.4 Theme 4: Awareness

Participant X2 replied with "... *really, I am not sure, tell me please!"*. "*It's not good to be surrounded by trash you made yourself*." said X5. X7 stated that "*. . . pisses all over the place and makes the place smell bad, so does e-waste make the environment look bad and it must be cleaned.*" To these participants this type of waste is about cleanliness and hygiene, nothing more. Electronic waste is not about clean surroundings, but a monster ready to devour its prey when let loose due to its toxicity. Table 6-18 list code incidence frequencies for electronic waste damages related to theme 4.

Table 6-18: Code incidence frequencies for electronic waste damages

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Understanding the unfavourable impacts of e-waste	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not knowledgeable about the disastrous implications of e-waste	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14

6.7.3 Mapping CSH (questions)

Table 6-19 shows a summary of participants' responses during the diagnosing phase of TVET (case 3).

Table 6-19: Mapping critical systems heuristics (Diagnosing)

Source of influence	**X1**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Scrap pickers or collectors"* • *"They make cash for families"*	• *"Donate to the needy"*	• *"I don't know because from my subjects GIT is not talked about".* • *"I think e-waste is something not needed. The word waste says it all, with GIT I am not sure"*	• *"Because of chemical composition they may spoil soil for farming".* • *"The best way is to repair or give it to scrap collectors to make money from selling to recyclers".* • *"Scrap collectors knows where to sell it; therefore, they clean the environment by collecting and selling it"*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"The people".* • *"We will save trees that shade us".*	• *"Throw into rubbish bins if not working ".*	• *"There are no GIT initiatives, therefore I think is not dealt with adequately".* • *"I think GIT is the opposite of e-waste, while e-waste is dirt to be disposed ".*	• *"I think it pollutes water when dumped into rivers placing water living things live into danger".* • *"Leaving it into municipality garbage bins is the best option".* • *"Municipalities are equipped with equipment and knowledge on how to dispose waste"*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"I am not sure what is GIT".* • *"It will be difficult to answer because I don't know what GIT is"*	• *"Keep in the spare rooms and call municipality to pick it up".*	• *"I think is not practised only general waste is talked about".* • *"Electronic waste are computers that are not needed, and GIT represent ways to make computers green ".*	• *"I think is dangerous to health since it is waste".* • *"Keep it in rubbish bins for municipality to collect".* • *"Municipality are garbage collectors as a result they know how to dispose it safely".*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"It is first time to hear about the term GIT".* • *"Since the word GIT has green, I think land especially trees or nature will benefit ".*	• *"Put it away in the municipality rubbish bins ".*	• *"Most they talk about climate change but never hear about e-waste practices in the institution".* • *"Green information technology is making computers good for the environment and e-waste makes environment bad and not healthy ".*	• *"Electronic waste makes the environment dirty thereby exposing people's health to danger".* • *"I think burning is the solution".* • *"Burning will consume the waste, nothing beats fire ".*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Because we are taking about IT, therefore IT companies will benefit".* • *"They will make solutions that people will buy ".*	• *"Hand it over to municipality for disposal, otherwise repair it"*	• *"I don't know because GIT is new to me".* • *"As I indicated early, I don't know what GIT is, but with e-waste I understand are computers and printers not*	• *"I think fumes of cables are dangerous to human health".* • *"Repairs can be a solution instead of burning it".* • *"When you repair, saving is from buying the new IT ".*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"People who work with IT".* • *"They will take advantage of benefits offered by GIT ".*	• *"They have technicians that could do the repairs. Otherwise dispose in local dumping sites ".*	• *"No one talks about it GIT, our including the lecturers".* • *"Electronic waste is something that uses electricity and not wanted by the owner anymore reasons ".*	• *"I think it causes air pollution due to fumes resulting from burning".* • *"Because it is a waste sell it to scrap yard people for recycling".* • *"When you recycle you save the use of raw materials to produce other new products ".*
Source of influence	**X7**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"I don't want to lie, what is GIT? . . . Mm!"* • *"Maybe. . . reaping benefits from what you call GIT ".*	• *"Burn it from local landfills or sell to scrap yards".*	• *"I am not sure because no one is talking about GIT even teachers during the lecture they are silent on the topic".* • *"Electronic waste is unwanted IT equipment by the owner and GIT are ways to make computers not dangerous to people and land as well ".*	• *"It makes environment untidy, and dirt make people sick".* • *"I think donations or reuse is the best option".* • *"Reuse preserve raw material that could have been used to manufacture a new product"*
Source of influence	**X8**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The society benefit from GIT".* • *"I am not sure how, but GIT is meant for us ".*	• *"Give it to us as employees or sell to local recyclers for extra cash ".*	• *"You will sometimes find old computer components in rubbish bins or computer wires around the campus, But I am not sure how that relates to GIT practices to the college".* • *"Green information technology deals with ways to make use of less electricity and e-waste are computers that have no value to us as users ".*	• *"Because is waste, it can cause sicknesses and even death".* • *"You can bury it into soil like we do compost or burn it".* • *"When is buried under soil it cannot be exposed to people or dirty the environment ".*
Source of influence	**X9**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Companies who develop GIT products".* • *"They will make money from this product ".*	• *"Save some for us to do practical on how to fix computers ".*	• *"No comment".* • *"Electronic waste are computers we don't need, and GIT find ways to make those computers functional again. Because GIT has the word 'green', that means functional again in a way safe to the users ".*	• *"Electronic waste components are harmful to health".* • *"I think municipal landfill is the safe way".* • *"Municipality knows the ways to deal with waste".*
Source of influence	**X10**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"People who sell old components of GIT".* • *"With employment that generate cash for them ".*	• *"I think they should give to the needy organisations or let us practice on how to fix the broken computers. The rest dispose into dumping sites ".*	• *"We are not told what to do with IT equipment we do not need. You will always see abandoned cell phones and batteries around the campus".* • *"Anything of electronics you don't want and GIT what makes computers safe to the users health".*	• *"Electronic waste pollutes the environment and thereby making people sick".* • *"I am not sure about this one".* • *"Can you please tell me sir? Since not sure about safe disposal methods ".*
Source of influence	**X11**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"I think the environment".* • *"It will save the environment. I learnt that every technology that has word green is meant for the sake of the environment ".*	• *"I am not sure, but they should have a way to deal with it ".*	• *"I don't know because is not spoken about".* • *"I think e-waste is anything that uses electricity, and you don't want is, while GIT inform us to use IT devices in a safe way ".*	• *"I think they make people sick because is something people don't want. I mean e-waste".* • *"Dismantling the e-waste to get materials for new products is the best way for me".* • *"Recycling produces new products from same materials ".*
Source of influence	**X12**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"People who work and design these products".* • *"If they are only ones, they will lead the market and make more money"*	• *"I think some should be left for us to learn how to do repairs, and give to churches and others the working ones"*	• *"I think they are not in favour as no one is talking about it".* • *"Anything of electronics you don't want and GIT what makes computers safe to the users health"*	• *"I once read from a magazine that e-waste can kill".* • *"Donating to the needy is the right method to deal with e-waste".* • *"When you donate you give to someone to use not litter"*
Source of influence	**X13**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"I don't know what GIT is?"* • *"Can you help sir? I told you no clue of what GIT is"*	• *"They should give to use the needy students and use spare other items for us to use in laboratories"*	• *"I am not sure, but the one thing that I am sure about is that no one teaching us about it".* • *Anything device that uses a cable for power and GIT ways to make such devices safe to use"*	• *"To health not sure but it can pollute water".* • *"Selling it to people who dismantle it for valuable materials".* • *"When you sell to people who dismantle it for valuables you clean the environment. secondly dismantlers know how to dispose it safely"?*
Source of influence	**X14**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions	Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses	• *"The environment and human health"* • *"Trees will be saved as less paper will be needed. People will reap benefit of trees. For example, clean air for us"*	• *"They are educated and therefore they should know how to deal with it"*	• *"I think is not practised, because you will always see cell phone components lying around the campus".* • *"Electronic waste is something that is not wanted by users and GIT helps on producing safe products of IT"*	• *"Electronic waste can leak harmful materials that could possibly mix".* • *"Leaving the problem to municipality is the proper way to deal with e-waste".* • *Municipalities know how to deal with e-waste"*

The participants' responses, as they relate to CSH framework are discussed next.

6.7.3.1 Motivation

Question(s): Who gains from GIT, and in what ways?

X11 said that GIT is beneficial to the "*environment*". X14 said, "*Human health*." X7 asked, "*What is GIT? I don't want to lie. . .. mm!*". Though some show a certain level of understanding about beneficiaries, there is still room for education. This can be easily picked up from X7's replies on the question asked. "*Can you help, sir?"* X13 asked. "*I informed you that I had no idea what GIT was*" (X7). Furthermore, participants need to be educated in what ways GIT benefits the biosphere and human wellness.

6.7.3.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

X5 said that "*Hand it over to the municipality for disposal or repair it*." X11 remarked, "*I'm not sure, but they should have a means to deal with that*." Putting together electronic waste is not recommended. Garbage collected by municipalities has been a thorny subject within many knowledgeable communities, as municipalities treat garbage inappropriately. Combining e-waste with the household waste collected by municipalities aggravates the dangers posed by e-waste. Municipalities mainly dispose of waste in landfill sites. Landfills are the source of waste seeping into the soil.

6.7.3.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?

"*I don't know because GIT is not discussed in my subjects*," X1 responded. X1 takes us back to the issue dealt with earlier; that is, a need to integrate environmental issues, especially pertaining to the context of the study into the curriculum (Msengi *et al.*, 2019:1; Tangwanichagapong *et al.*, 2017:204). The following remark indicates that education is needed regarding the problem statement of this study. X1 said, *"I don't know because from my subjects GIT. . . not talked about"* (X2). However, X2 claimed that "*e-waste practices in the institution are never brought up*."

6.7.3.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Participant X2 said that *". . . it pollutes water when dumped into rivers placing water living things lives into danger"*. It does not only endanger aquatic life, but also the lives of those who consume seafood and river fish and drink the water. X2 said, *"Leaving it into municipality garbage bins is the best option"*. Landfilling is not effective as it is currently practised, especially in the regions in the southern hemisphere (Bhat & Patil, 2014:491). Municipal bins are not an option as discussed earlier. Other participants prefer donating. Yes, to donate is morally correct. However, donations should not be made as a disguise for disposal. X7 said, *". . . donations".*

6.8 University (case 4)

Investigation was carried out on one of the campuses of this nationally and globally renowned HEI, which has a student community of over 3 500 on all campuses.

6.8.1 A brief history of the participants

All the participants were undergraduates. Most of them were studying natural sciences.

6.8.2 Themes generated (interviews)

After analysing the university data, the following themes emerged: education, GIT recipients and benefits, e-waste knowledge and comprehension, and disposal.

6.8.2.1 Theme 1: Education

Yet again the challenge of curriculum integration with e-waste issues is raised. "*E-waste management should be covered in our studies*" (X10). "*Because it has an impact on us,*" replied X10. To begin with, education can start with institutional campaigns via printed or online media and gradually progress to the curriculum. Neglecting issues of e-waste integration into the curriculum has left us behind regarding this essential matter (Maphosa, Macherera, Zezai & Mangwana, 2022:5409). Table 6-20 shows code incidence rates for incorporating e-waste instruction in the curriculum related to theme 1.

Table 6-20: Code incidence rates for incorporating e-waste instruction in the curriculum

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Not sure as yet	0	0	0	0	0	0	0	0	0	0	0	0
Integrate with curriculum	1	1	1	1	1	1	1	1	1	1	1	11

6.8.2.2 Theme 2: Terminology

X11 said, *"Green information technology is interacting with co-workers without using paper".* As it has been alluded to in the previous instances (cases of this study), most participants seem to confine GIT to saving paper by using electronic media for communication. Needless to say, GIT is a broad subject (Ribeiro *et al.*, 2021:1). "*Anything that uses electricity . . . and thrown away*" (X10). The response obviously calls for more education on the subject of electronic waste and computing sustainably. Table 6-21 list frequency codes on terminology pro-environment and electronic waste related to theme 2.

Table 6-21: Frequency codes on terminology pro-environment and electronic waste

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Electronic trash	1	1	0	0	1	1	0	0	1	0	1	6
Computing sustainably	0	0	0	0	1	1	0	0	0	0	1	3

6.8.2.3 Theme 3: Disposal

Participant X1 stated, "*I prefer to store the gadgets that aren't in use at home because you never know when you might need them*." X4 responded, "*. throw it away or burn it!*". Leaving unused gadgets in an identified location or burning or discarding them is merely a repetition of the responses in the previous cases or instances. Burning should always be prohibited. The emitted fumes are not suited for our systems. Humans are made to breath clean air for optimal well-being (Nyeko, Mlay, Amerit, Abima, Among, Nyero, Odiya & C., 2023:2). Table 6-22 shows frequency of codes for disposing of electronic waste related to theme 3.

Table 6-22: The frequency of codes for disposing of electronic waste

Content \ Participant	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Dwelling place keeping	1	0	1	0	1	0	0	0	1	1	0	5
Discard	0	1	0	0	1	1	0	1	0	0	1	5
Selling/giving	0	0	0	0	0	0	1	0	0	0	0	1

6.8.2.4 Theme 4: Adverse effects

"*When left unattended, computer wires might easily trip someone*" (X5). X11 stated, "*Screen contains toxic chemicals . . . ".* These participants had a certain level of knowledge about the negative effects of electronic waste. However, X2 still battled with the matter. X2 was quoted as saying, "*Could you please tell me of any?*". Table 6-23 display code incidence rates about harmful impacts of electronic waste related to theme 4.

Table 6-23: Code incidence rates about harmful impacts of electronic waste

Content \ Participant	X1	X2	X3	P4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Aware	0	0	0	0	1	1	0	0	0	0	1	3
Not aware	1	1	1	1	0	0	1	1	1	1	0	8

6.8.2.5 Theme 5: Benefits and beneficiaries

Participant X1 stated, "*green information technology allows for paperless transactions*". X4 remarked, "*GIT allows us to conduct transactions without using paper, thereby saving trees*." X7 is of the opinion that "*industries that produce green products will make maximum profits*". In this day and age, people want products that are sustainable. More and more, people are becoming informed about the benefits of going green. However, the participants seem to limit green information technology transactions to transactions that need no paper. X3 and X5 also believed that paperless transactions are the sole purpose of GIT. Table 6-24 shows code incidence rates for the advantages and users related to theme 5.

Table 6-24: Code incidence rates for the advantages and users

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Recipients	1	0	1	1	1	0	0	0	0	0	0	4
Advantages	1	0	1	1	1	0	0	0	0	0	0	4

6.8.3 Mapping CSH (questions)

Table 6-25 shows a summary of participants' responses during the diagnosing phase of university (case 4).

Table 6-25: Participants' responses (diagnosing)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *Who gains from "GIT", and in what ways?*	• *"They should refurbish it".*	• *"It is not practised because there are no marked bins for e-waste, as an example.* • *"Electronic gadget not wanted are e-waste and GIT helps with ways to make waste not harmful to us"*	• *"Makes us ill by dirtying the environment.* • *"Keep working components for future use. Then send the rest to municipality bins".* • *"When you send to municipality you clean the environment"*
Sources of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment benefit from GIT"* • *"By saving trees for making paper"*	• *" I think waste should be left to municipalities to handle"*	• *"Computers are left running unattended in our laboratories and lecturer halls, so it is not practiced".* • *"Green information technology has to do with the environment while e waste is something that you don't need any longer"*	• *"I am not sure yet, but we all know that dirt is not good for health. It makes environment dirt with components lying around".* • *"Take it to scrap yards for recycling or let scrap "collectors have it to make cash for themselves".* • *"You will be creating jobs for scrap collectors".*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Community"* • *"Because GIT does not harm people or users of it"*	• *"University personnel is educated; therefore, they are in a better position to direct what should be done with these equipment"*	• *"There are no campaigns or marked bins to dispose old IT equipment".* • *"With GIT I am not sure, but e-waste are things such as computers or cell phones that we don't need anymore"*	• *"Electronic waste when not managed properly makes people sick and could even cause death due to its toxic metals. It pollutes the environment."* • *"Reduce and repair or refurbish the IT equipment".* • *"When you reduce you stop from purchasing IT equipment that is not environmentally friendly. Again, when you repair or refurbish you extend the life of the existing device".*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"The environment for sure"* • *"I think resources like trees will be saved"*	• *"I am not sure but here we have Professors who should know how to manage e-waste"*	• *"I would say we are not taught about it in our curriculum, the I presume that is not practised".* • *"I am not sure about both terms."*	• *"It can pollute the water for household and the plants that we consume for food. Eventually we will get sick and even die".* • *"I think there is no best way to deal with problem of e-waste unless we stop producing it. for example, formal recycling still poses health hazards".* • *"With recycling you produce other products from the recycled materials…"*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Companies that manufacture GIT products".* • *"They will profit from these products as not all will be manufacturing them"*	• *"Store it for future practical students to learn how to fix IT equipment"*	• *"You will always find cell phone components and other cables when you go around the campus, this shows is not practiced as it should".* • *"With GIT I don't want to lie but e-waste is electronic equipment such as cell phones and computers that are not working"*	• *"Waste is bad for our health as it brings sicknesses".* • *"I think donating to others is the best thing to do".* • *"When you donate you help those who are in need".*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"People will benefit".* • *"The new market of GIT products will create new jobs"*	• *"Really, I don't know what to say on this one"*	• *"They sometimes talking about climate change a bit in our subjects but not e-waste per se".* • *"Anything that use electricity and not needed is e-waste, GIT can be a way of making sure that equipment is not harmful to the environment".*	• *"Makes environment dirt and eventually us ill "* • *"Call in municipality to collect for disposal".* • *"Municipalities are the ones responsible for collecting trash".*
Source of influence	**X7**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Ï think is the environment".* • *"If technology is green whatever will be dumped to the environment won't do any harm to it".*	• *"They should give working equipment to students or workers"*	• *"What is GIT? I am not sure how to answer the question".* • *"Electronic waste is referring to all electronic equipment we don't need. GIT, I am not sure, but it has to do with green technology as the name suggests"*	• *"Electronic waste parts are toxic and pollute soil and water".* • *"We should let municipality deal with e-waste".* • *"Municipal people have been working with waste for years. They know best ways to dispose e-waste".*
Source of influence	**X8**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Organisations that uses paperless transactions".* • *"They will save money on buying papers"*	• *"I think they should sell to the e-waste collectors, maybe"*	• *"They are ignorant; they talk about all other issues but not GIT specifically".* • *"Green information technology is about making current technology green including the one in the future. Electronic waste is what is not green technology that is unwanted"*	• *"Toxic metals will make us develop health difficulties and these toxins pollute air".* • *"Call in e-waste specialist to collet it".* • *"Municipalities are the ones responsible for collecting trash".*
Source of influence	**X9**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The user of GIT products will benefit".* • *"The word green is always associated with safety; therefore, they will be safe from using this product"*	• *"Send for recycling or reuse what is functional"*	• *"What we see is cleaning of solid waste, not anything about e-waste".* • *"Green information technology refers to the ways that helps with clean environment while e-waste is anything not needed like computers and printers"*	• *"Electronic waste contains harmful substances that can cause health problems".* • *"Sell to people who sell scrap or burn it where necessary".* • *"Burning reduces waste of any kind".*
Source of influence	**X10**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"People"* • *" There will be no need to travel distances to discuss issues such as economies or strategy for businesses".*	• *"Give to the needy please! If you don't need it why keep it?"*	• *"I am not sure, and to start with what is GIT sir?"* • *"I think GIT is a term used to methods for making computers safe and e-waste is unsafe and unwanted computers"*	• *"Electronic waste makes people sick because it is waste. Electronic waste can pollute water and air".* • *"Recycling is the safest method, because you build other products from the recycled materials".* • *" You use the recycled products for other new products. Raw materials are saved".*
Source of influence	**X11**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses	• *"The government"* • *"The government will collect taxes from GIT products"*	• *"Allow municipality to collect or give to non-governmental organisations"*	• *"No one is talking about it including our lecturers, therefore is not practiced well enough".* • *"Anything that works on electricity and not useful, GIT, GIT reduces dangers associated with the usage of IT devices"*	• *"Waste is opposite to hygiene; therefore, e-waste makes us fall ill".* • *"I would say municipality route is the safe way to get rid of waste".* • *"Municipalities are waste collectors for centuries. They have developed efficient ways of collecting waste"*

The participants responses as they relate to CSH framework are discussed next.

6.8.3.1 Motivation

Question(s): Who gains from GIT, and in what ways?

"Organisations that use paperless transactions. They will save money on buying papers" (X8). X10 said that "*People. There will be no need to travel distances to discuss issues such as economies or strategy for businesses*." X2 said that "*The environment. By saving trees for making paper*". Though they are correct about the benefits of GIT, when comes to in what ways, their responses seem to be limited to "*saving paper*". Green information technology is more than just preserving trees and saving costs on paper. X5 believed that companies producing green products will benefit. They will indeed benefit, as more people are conscious of sustainability issues. Furthermore, more jobs will be created indirectly (Bhardwaj, Garg, Ram, Gajpal & Zheng, 2020:2).

6.8.3.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

"*I think waste should be left to municipalities to handle*, remarked X2. "*I believe that waste management should be left to municipalities". "Give to the needy please",* said X10. However, donations come with the responsibility of not "*abandoning disguise*". In short, those who give must make sure that the donation will be taken care of when it is no longer working. Municipalities also struggle with general waste disposal because landfill sites become full, therefore leaving the problem for municipalities to solve on their own is not the solution (Ogundele, Rapheal & Abiodun, 2018:62).

6.8.3.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation?

As per X1, *"GIT is not practiced . . . no marked bins"*. X2 stated, *"Computers are left running unattended . . .* ". Leaving computers running consumes energy and contributes to the carbon footprint (Sutton-Parker, 2020:485). In this case, there are no initiatives for GIT processing. This is noted from X1's response.

6.8.3.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

X11 said that "*Municipalities are waste collectors for centuries. They have developed efficient ways of collecting waste*". Indeed, municipalities have been trusted with waste removal since the inception of these entities. However, research shows that they are battling with other types of solid waste disposal (El-Saadony, Saad, El-Wafai, Abou-Aly, Salem, Soliman, Abd El-Mageed, Elrys, Selim, Abd El-Hack, Kappachery, El-Tarabily & AbuQamar, 2023:2; Viljoen, Schenck, Volschenk, Blaauw & Grobler, 2021:1). It is not advisable to delegate e-waste removal and disposal to municipalities, as they are reliant on landfill sites. "*Recycling is the safest method, because you build other products from the recycled materials,*" commented X10. Recycling, if carried out under official guidelines is recommended (Dutta & Goel, 2021:163). In the literature, it was noted that after processing, informal recyclers often discard the sludge of the waste into water sources, such as rivers (Rao, 2014:1344). According to X9, "*Burning reduces waste of any kind* ". Toxic emissions from e-waste during burning, is detrimental to well-being. Once again this is an indication of the lack of knowledge and understanding and the need for education regarding e-waste and GIT practices.

6.9 Similarities and differences

There are no strict guidelines on the number of instances (cases) needed to fulfil the replication strategy's requirements in the multiple-case studies design (Zach, 2006:9) when doing analysis between and within cases in order to remove the unnecessary data (Quintão & Andrade, 2020:267).

- **Case 1 (university of technology)**

Necessary information for case 1: The participants were ITTs and the data gathering methods were interviews and auto-photography. The data analysing methods were content analysis and the CSH framework. The sampling strategy was purposeful sampling. Analysis within a case (case1) revealed that data analysed both from auto-photography and interviews showed converging findings (current level of awareness was low). The findings support the literature in that HEIs have low awareness levels of the negative impacts of e-waste and GIT practices (Ali & Akalu, 2022:2).

- **Case 2 (TVET college)**

Necessary information for case 2: Participants were ITTs and the data gathering methods were interviews and auto-photography. Content analysis and the CSH framework were used to analyse the participants' information. Purposeful sampling was used as the sampling strategy.

Findings within a case: the participants were found to have low levels of awareness regarding e-waste effects and GIT practices. The findings are consistent with the literature (Abalansa *et al.*, 2021:1).

Findings between cases: When comparing two cases, the findings are similar. Both cases share a common focus or goal in the diagnostic phase.

- **Case 3 (TVET college)**

Necessary information for case 3: The participants were students and interviews were used for data collection. The data was analysed, using content analysis and the CSH framework. The strategy for sampling was purposeful. The case's conclusions are found to be consistent with the literature in that HEIs are unaware of GIT and e-waste procedures (Miner *et al.*, 2020:4).

- **Case 4 (university)**

Necessary information related to case 4 is the following: The data gathering method was interviews. The sampling strategy was purposeful. The data within a case were analysed through content analysis and the CSH framework. Students were the participants for this instance (case). The findings in the case were advocated by the literature (Maphosa, 2021:563).

Four cases are consistent with the goal of literal replication (Perry, 2001:314). The findings from the cases are similar in that a paucity of knowledge is prevalent in HEIs with regard to the study problem (Ali & Akalu, 2022:2; Maphosa, 2021:563). In the diagnostic phase, the findings can be replicated.

6.10 Summary

The study problem was identified and justification to continue with the study was made. In the next section, there is a brief discussion on how this was achieved.

To identify the problem the data was gathered from each of the four instances, using interviews and the auto-photography method. The researcher intended to add official documents, but during this phase, they were not made available for all the cases. Not all instances provided photos. The researcher was only able to obtain photographs from participants for analysis in two cases. The gathered data was analysed by means of content analysis to generate themes. Quantitative content analysis, in addition to qualitative content analysis, was used to enhance the understanding of the data. Critical systems heuristics was also applied as a method of analysis. From all the cases, the findings revealed that there is a lack of awareness about electronic waste and green information technology. The identification of the problem justified continuation of the study. The findings from the cross-analysis of the cases were similar (prediction for literal replication).

In the next chapter, the study's intervention, developing the solution to the problem and creation of the artefact (digital story), is presented.

CHAPTER 7 DEVELOPING A SOLUTION

7.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

The focus is on how the design science research process of activities in developing artefacts were applied in the development of the digital story. The chapter is not only limited to the development of the digital story during action planning, but also includes how the digital story was shown to the participants in action taking. The action research action taking in this study includes the process of showing the digital story to the participants. The working definition for a digital story, in this study, is: a short story, of 2 to 10 minutes, comprising of still or moving pictures, and a narrative; composed using a digital editing computer software (Ofoegbu, Asogwa, Ogbonna, Aloh, Eseadi, Eskay, Nji, Ngwoke, Agboti, Nnachi, Nnachi & Otu, 2020:2; Robin, 2016:18). Digital storytelling was chosen because the literature has shown that digital storytelling is a powerful tool to improve knowledge transfer and create awareness (Blithe, Carrera & Medaille, 2015:62; Ofoegbu *et al.*, 2020:2). Stories are made to be listened to and therefore there must be a method to get your story to the attention of the targeted audience (Robin, 2016:21).

In Section 7.2, how design science research is applied in digital story development is discussed. In Section 7.3, the developed artefact will be tested in the action taking phase of the action research design. In Section 7.4, a summary concludes the chapter.

7.2 Action planning phase and design science research

The planning phase employs the following design science research (DSR) phases: problem awareness, idea generation, development, and evaluation.

7.2.1 Problem awareness

The problem as identified in the diagnostic phase. The problem was identified after analysing the data collected primarily through interviews. The data was analysed with content analysis and the critical social heuristics (CSH) framework. The findings pointed to a low level of awareness of green information technology (GIT) practices and electronic waste (e-waste) impacts on the biosphere. The findings were similar in all four instances or cases.

7.2.2 Suggestion

The purpose of the suggestion phase is to make suggestions regarding the artefact (digital story) by defining the requirements of the artefact. The requirements are digital story mapping, the approach to build the artefact, including tools needed to create the intervention (artefact). The researcher will follow Ohler's story mapping (Ohler, 2006:45) And use Kadjer's approach to implement the digital story (Kajder *et al.*, 2005:40).

7.2.3 Development and evaluation

In the development and evaluation phases of DSR, the activities that are completed to develop and evaluate the digital story to be tested in the evaluation phase of the AR are explained. In this study, a short narrative (lasting two to 10 minutes) that includes still or moving photos, a narration, and that will be created by using a digital editing computer program is referred to as a "*digital story*" (Ofoegbu *et al.*, 2020:2; Robin, 2016:18). Digital storytelling (DS) was chosen because the literature has shown that DS may be an effective technique for creating awareness and bettering knowledge transmission (Blithe *et al.*, 2015:62; Ofoegbu *et al.*, 2020:2). There are several methods for creating or constructing digital narratives, and in this study, Kajder and others' strategies are also employed (Kajder *et al.*, 2005:40). They recommended starting with a draft storyboard, developing the script through discussion and revision, arranging the pictures, narration, addition of transitions and other effects, and concluding by adding a musical background (Moradi & Chen, 2019:6). In addition to the method of Kajder *et al.* (2005:40), story mapping is added to the development of the digital story (Laina & Marlina, 2018:266; Ohler, 2006:45). The activities, starting with story mapping up to the final activity in the artifact development, are depicted in Figure 7-1.

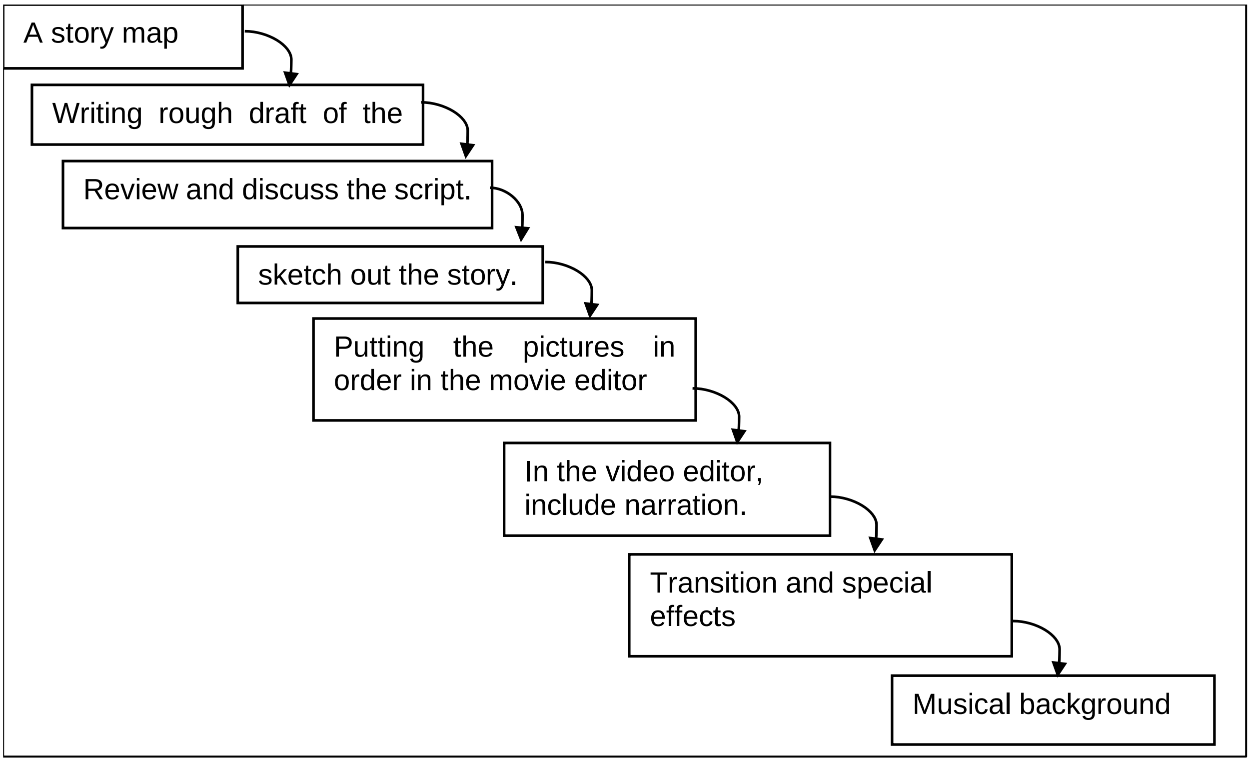


Figure 7-1: Steps for developing the digital story

The steps for developing the digital story is discussed below:

- The first activity is story mapping. The importance of story mapping is to create digital stories with depth (Laina & Marlina, 2018:266; McCall, Shallcross, Wilson, Fuller & Hayward, 2019:1).
- Initial phase (adventure call): Higher education institution faculty members, John and Alex, are overburdened by a load of information technology equipment not in use.
- Stage of the problem (tensions): They are struggling to figure out what to do with the abandoned equipment.
- Middle (conflict): John and Alex do not appear to agree on how to get rid of the e-waste. They each offer a unique strategy for handling the e-waste.
- Solution: During the conflict, Alex switches on the radio. Fortunately, a new programme is being aired that aims to inform listeners how to handle abandoned equipment. They both agree to listen to the programme. Listeners could air their opinions on the topic during this broadcast by dialling in. By the end of the programme, John and Alex realize that their suggested disposal techniques are, in fact, detrimental to the ecosystem and the

environment. After realising that their ideas would be harmful to the environment and the public's health, they express their regret for their earlier strategy.

- Conclude (closure, learning): Through the radio programme, Alex and John learned something regarding the issues with GIT procedures and e-waste.

- The story mapping activity is followed by the preliminary script.

The conclusions or findings of the action research (AR) diagnostic stage served as a guide for the first draft of the digital narrative. The goal of writing a script first is to prioritise the story over technology (Al Najar, 2018:144). The most important resources for creating the digital story are script writing and story treatments (Laina & Marlina, 2018:266; Ohler, 2006:45). The majority of digital story developers and creators find themselves emphasising technology rather than the narrative (Foelske 2014:2; Moradi & Chen, 2019:2). In order to create a good story, the choice was to start with the story and then move to the technology (Al Najar, 2018:144; Ohler, 2006:45). After the preliminary script was completed, it was discussed and revised.

- **Storyboarding**

It is advisable to employ a storyboard, which is an ordered presentation of illustrations or photographs that summarises the major plot action (Al Najar, 2018:144; Ohler, 2006:45). Storyboards are used to plan the intervention (O'Byrne *et al.*, 2018:3). Storyboard was employed in a format created by Walt Disney (ANNEXURE F) and that filmmakers use to create a visual framework (Ayrton, 2020:1235). The format featured parallel frames or panels with material on one side that represented the information on that screen and a representation of how the screen will appear on the other side. Table 7-1 shows a hand-drawn example of a storyboard.

Table 7-1: Template for Walt Disney storyboards

Illustration	Description
	Radio personality: "Hello and welcome to the first and last program"

When storyboarding, there are no rules on how to do it. This method has only positive effects (Ayrton, 2020:1235). The storyboard illustrations for this research were produced by hand, using A4 size paper and a pencil (ANNEXURE E). There are countless photographs and photos available online, both for free and for sale (Robin, 2016:24). The researcher wanted to create his own work for this study, therefore the graphics were created by hand (Kajder *et al.*, 2005:41). Using a desktop computer and scanner, the drawings are scanned after being created by hand to create soft copies or digitised images (McCarty, Gołofit, Tigges & Skalski, 2018:1346; Wang & Zhan, 2010:82). An iterative method was used to revise the storyboard until it was helpful and clear. The storyboard was shared with the public and opinions were solicited on what could be added or removed to make it more understandable and helpful.

- **Pictures in order and narrative**

The produced script was augmented with various forms of multimedia, such as sound, graphics, and text, utilising the digital storytelling (DS) approach to create a digital narrative. Using the smartphone apps Adobe Illustrator Draw and InShot App, the photos were coloured and modified. To tell the story of Alex and John, (two digital story characters), narration was inserted as text. To add text to the video editor accessible from a smartphone, the researcher utilised the Inshot program.

- **Inserting a musical track**

Incorporating background music that complemented the narrative and was appropriate for the story's premise, as recommended by Robin, gave the narration more depth (Robin, 2016:24). The researcher looked for background music on the internet. The tracks on the DS were taken into account for copyright, as proposed by Robin (2016:24).

- **Special effects with transitions**

To give the hand-drawn images in the digital story a sense of motion, special effects and transitions were used. Transitions made it easier to go from one image or character to the next as the narrative developed. The KineMaster program was used to merge the photographs or pictures. The materials used to create the digital story are depicted in Table 7-2.

Table 7-2: Materials needed to create the digital story

Materials	Function of the materials
A4-sized sheet and pencil	The drawings are by hand
Web page	Publish and distribute the online narrative
The scanning device	Make a soft copy of the photographs.
The Adobe Draw program	Finalising picture edits through cropping
Website FreePD.com	Get the audio file
Internet-connected Dell laptop	Conduct research on topics that are influenced by the themes identified during this study's diagnostic phase.

Materials	Function of the materials
Phone that is smart	Hardware required to operate mobile apps (such as Adobe Illustrator and InShot)
Application for Inshot application	Digitally alter hand-drawn images (such as by colouring and fading them)
Video editor called KineMaster	Make a digital narrative
The DVD and an external hard disk	Save the online narrative

- **Preserving the digital story**

Digital information may be damaged or changed without being noticed and is unstable in ways that are different from previous technologies. Some types of information, including digital narratives, are inaccessible outside these protected settings due to their close relationship with hardware and software technology (Şeker, 2016:18). It is critical to preserve and archive digital information. The digital story or artefact from this study should be archived and preserved in order to maintain its worth and make it accessible in the future. There are benefits and drawbacks to each digital information archiving technique (Keneley, Potter, West, Cobbin & Chang, 2016:76). In this study, the digital story was stored on an external hard drive on a DVD and kept secure in an office closet. The digital story was archived by the researcher using google drive as well.

7.3 Action-taking phase

The action-making phase of AR is all about selecting a strategy for resolving the issue (Gibertonia *et al.*, 2016:377; Shu, 2022:48; Susman & Evered, 1978:588). The participants were shown the digital account during this stage, and the best platforms to display the digital story were chosen. The digital story was shown to Case 1 (university of technology) participants. The aim was to test whether the digital story was welcomed before it could be rolled out to all the cases in the evaluation phase.

7.3.1 Showing the digital story

The digital story could be viewed on one drive or on a memory stick. Every participant used the one drive to view the digital narrative. To view the digital narrative click here.

Participants were shown how to view the digital story and provided with clarity or additional information where necessary. The participants had a week to view the narrative and respond when they felt their understanding of the digital story was complete. More time to watch the DS was afforded to the participants. The digital story was seen by participants at their favoured location and in their own time. Following the viewing of the digital narrative, the researcher verbally requested the participants to take part in the digital story's evaluation phase. This was done in addition to the consent form they had already signed.

7.4 Summary

In this chapter, the solution to the problem was developed. The artefact (digital story) was created. According to the literature, digital storytelling as a technique is hailed as a tool with potential to create awareness. In this study, the digital story was created in one of the instances or cases in the study (case 1: university of technology). Design science research as a paradigm of research, which strives to improve human knowledge via artefacts, was employed. The following phases of design science research; namely problem awareness, suggestion, development, and evaluation, were implemented in the process of creating the digital story as a solution to the study problem. Ohler’s story mapping and Kajder’s approach were incorporated.

In the next chapter, the evaluation and specifying learning phases of action research are discussed. The story will be tested, and the lessons learned from the processes of action research in this study will be specified.

CHAPTER 8 TESTING THE DIGITAL STORY

8.1 Introduction

The aim of this study is to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

The focus of this chapter is to evaluate the effectiveness of the artefact in solving the study problem and in addition, the evaluation and specifying learning phases of action research are presented.

The evaluation is done under four sources of influence, namely motivation, control/power, knowledge/expertise and legitimacy (Reynolds, 1998:5; Ulrich & Reynolds, 2020:356). The interview guide questions are mapped to critical systems heuristics. The participants, after watching digital story, are interviewed under the guidance of critical systems heuristics, supplemented with content analysis. The purpose of evaluation is to access the effectiveness of a digital story in creating awareness about hazardous impact of electronic waste in the environment and health. Evaluation is then followed by the specifying learning phase where the effectiveness of the action is considered when interpreting the outcomes of the evaluation phase, resulting in the recommendation of improvements based on the findings of the evaluation phase for subsequent iterations of a cycle.

A summary of the intervention for each case (higher education institution) is also provided in this chapter. Cross-case analysis is included for the evaluation phase.

In Section 8.2 participants who take part in the evaluation phase are described. In Section 8.3 and Section 8.4, data gathering and data analysis strategies, respectively are discussed. Evaluation and specifying learning phases for the university of technology (case 1) are discussed in Section 8.5. In Sections 8.6 and 8.7 the discussion is on the evaluation and specifying learning phases of the Technical and Vocational Education and Training (TVET) college (case 2) and the TVET college (case 3), respectively. The discussion on the university's (case 4) evaluation and specifying learning phases is provided in Section 8.8. In Section 8.9, cross-case analysis for either literal replication or theoretical replication is presented. Finally, a summary concludes the chapter in Section 8.10.

8.2 Participants selection

The following participant selection strategy discussion applies to all four instances (cases). The participants who participated in the previous action research (AR) phases were recruited to participate in the AR phase of evaluation. The argument is that the purpose of the evaluation is to determine the impact of the digital story on those who are known to possess low levels of knowledge related to the study's problem.

8.3 Data gathering

The data was gathered through semi-structured interviews carried out at the participants' convenience. All interviews were face-to-face through the medium of English. Interviews were used because they are a trusted data collection strategy, as suggested by (Monday, 2019:21). Interviewees could openly express their views and opinions (DeJonckheere & Vaughn, 2019:1). The data gathering strategy was applied to all cases (four institutions). Ethical considerations were upheld.

8.4 Data analysing

The interview questions used in the diagnostic stage were used again in testing the digital story. The aim in using the same interview questions was to determine the impact of watching the digital story. The data analysing strategy was applied to all four instances or cases. The data analysing techniques used in the evaluation phase were similar to those in the diagnostic phase (analysis by content and critical systems heuristics framework).

8.5 University of Technology (case 1)

Critical systems heuristics framework supplemented with content analysis are used in the evaluation phase.

8.5.1 Themes generated (interviews)

In the following section(s) content analysis was used to generate themes and code frequencies. The generated themes are: (i) electronic waste disposal practices that are current, (ii) knowledge about e-waste's impact on the environment and health, (iii) green information technology beneficiaries and benefits, (iv) institutional electronic waste (e-waste), (v) implementation challenges of green information technology practices, (vi) understanding the terms green information technology (GIT) and electronic waste.

8.5.1.1 Theme 1: Current disposal procedures

All participants identified recycling and donating as a primary effective disposal procedure. In the diagnostic phase, X6 mentioned recycling as a way to go for safe disposal. In the diagnostic phase, only X6 felt that recycling was an example of an effective disposal strategy. Digital stories, guided by the digital storytelling technique, can inform, as stated in the literature (Parola, Di Fuccio, Somma & Miglino, 2022:119). Participant X2 mentioned "*donate*". All except X1, believed that throwing e-waste away and/or leaving e-waste to the municipality for collection as best strategies to handle this type of waste. Seldom is it mentioned in the literature that the people receiving the donations should be informed about the aftereffects of this waste and the mismanagement thereof. Donations should be made in good faith not as a disguise to get rid of the item. In the literature, there are recorded cases where donations were offered in bad faith (Amechi & Oni, 2019:145). Table 8-1 display code incidence rates for electronic waste disposal procedures related to theme 1.

Table 8-1: Code incidence rates for electronic waste disposal procedures

Participant / Content	X1	X2	X3	X4	X5	X6	X7	Cumulative
Re-use	1	0	0	0	1	0	1	3
Minimise	0	0	0	0	0	1	1	2
Hand out to the needy	1	1	1	1	1	1	1	7
Recycle/ Regain material	1	1	1	1	1	1	1	7

8.5.1.2 Theme 2: Environmental and health effects

After watching the digital story X1 learned how detrimental e-waste is to the biosphere and human well-being. In the diagnostic phase, X1 was not aware of any reasons why mismanagement of e-waste could be harmful. The digital story indeed created awareness about the theme for this participant. Table 8-2 shows effects of electronic waste may be learned from codes of occurrence relating to theme 2.

Table 8-2: Effects of electronic waste may be learned from codes of occurrence

Participant / Content	P1	P2	P3	P4	P5	P6	P7	Cumulative
Effects of poisonous emissions to well-being, the biosphere	1	1	1	1	1	1	1	7

8.5.1.3 Theme 3: Gains and recipients

Participants X4 and X7 could identify neither the benefits nor the beneficiaries of GIT. However, after the digital story, they could easily identify benefits and beneficiaries of GIT. The digital story had created awareness about the theme for these participants. People, organisations producing green products, and the environment will all benefit as a result of acknowledging the benefits of GIT. The sentiments are also shared by the current research from various scholars (Alblooshi, Ahmad, Hussain & Singh, 2022:1857; Li, Qin, Zhu & Zhang, 2023:4). Table 8-3 display frequency rates about gains from pro-environment and its users relating to theme 3.

Table 8-3: Frequency rates about gains from pro-environment equipment and its users

Content \ Participant	X1	X2	X3	X4	X5	X6	X7	Cumulative
GIT recipients	1	1	1	1	1	1	1	7
GIT benefits	1	1	1	1	1	1	1	7

8.5.1.4 Theme 4: Handling of electronic waste by institutions

All the participants believed that waste is not dealt with appropriately by the institution. On the contrary, most felt it was poorly handled. According to the literature, some of the reasons that can be attributed to poor handling of this type of waste are poor knowledge about the impact of this waste and unresponsiveness by the managers and those in power regarding issues of sustainability (Ahmed, 2018:307). In the diagnostic phase, X1 was not certain how the institution managed e-waste issues. After viewing the digital story, X1 could take a stand and say that the institution battled with the effective management of e-waste. Before exposure to the digital story, X2 felt that e-waste was moderately managed in the institution. After viewing the digital story, X1 then said, *"the reason to lack implementation is paucity of understanding and knowledge about this type of waste*". This perspective is in line with the literature (Samoei, Moturi & Orwa, 2021:392) X1 was now is responding from a position of being informed. The story has enabled X1 to comment from an angle of knowing. Table 8-4 identifies the code occurrence frequencies for how the institution manages e-waste.

Table 8-4: Code incidence rates for the organisation's electronic waste management

Content \ Participant	X1	X2	X3	X4	X5	X6	X7	Cumulative
Inappropriately handled	1	0	1	1	1	1	1	6

Participant / Content	X1	X2	X3	X4	X5	X6	X7	Cumulative
Moderately handled	0	1	0	0	0	0	0	1
Adequately handled	0	0	0	0	0	0	0	0

8.5.1.5 Theme 5: Obstacles to the implementation of green computing

During the diagnostic phase, the major challenge for the institution to implement GIT was lack of financing and the unresponsiveness by those in power. After viewing the story, another barrier that topped the list had been identified as increased knowledge regarding the outcomes of the inappropriate handling of this solid waste. The changed perspectives of the participants is supported by the literature (Alziady & Enayah, 2019:4). It is true that initial cost is high, but over time, the benefits outweigh these costs. Table 8-5 shows codes frequency of occurrence about obstacles to implementation related to theme 5.

Table 8-5: Code's frequency of occurrence about obstacles to implementation

Participant / Content	X1	X2	X3	X4	X5	X6	X7	cumulative
Uninformed	1	1	1	0	0	1	1	5
Refusal to alter	0	0	0	0	0	0	0	0
Monetary assistance	0	0	0	1	1	0	0	2

8.5.1.6 Theme 6: Green computing and electronic waste terminology

Before viewing the digital story, most participants struggled with defining e-waste and GIT, particularly X4 and X5 (Table 8-6). The story has created awareness in this regard. Participants who had minimal understanding in the diagnostic phase now had a broader understanding. Understanding the terminology puts a person in a position to change behaviour over time. Table 8-6 shows frequency of codes pertaining to the definitions related to theme 6.

Table 8-6: The frequency of codes pertaining to the definitions

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	Cumulative
I'm familiar with e-waste and GIT	1	1	1	1	1	1	1	7

8.5.2 Mapping CSH (questions)

Table 8-7 shows a summary of participants' responses during the evaluation phase of university of technology (case 1).

Table 8-7: Participants' responses (evaluation)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"People and animals"* • *"Technology used is environmentally friendly which reduces the climate change problems"*	• *"They should donate such equipment and inform the people donated about the dangers of e-waste. The line managers and top management has the power to control how e-waste is managed".*	• *"Lack of information about negative impact of e-waste and where to put e-waste. No one cares! The management must make people aware by introducing awareness programs, then employ skilled people if they do not have one to implement GIT. Lastly, the management has the power to decide to buy environmentally friendly products".* • *"Electronic waste is any unused or discarded electronic or electrical device. Green information technology is use of clean technology in IT industry which reduces the negative impact on human health and environment as well"*	• *"Electronic waste releases toxic fumes that can poison all living things and disturb ecosystem".* • *"Recycling and reuse"* • *"Recycling because unwanted electronics can be transformed into useful materials. reuse because unused electronics in one place can be used somewhere else"*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions	Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses	• *“Both organisations and its employees”* • *“When e-waste is managed in a safe way it would improve the health of staff as they won’t be drinking contaminated water as an example”*	• *“They should donate an unused equipment to the community. If that equipment cannot be used any longer it must be kept in a safe place where it can be recycled. The government as law maker and major funder of the institution has the ultimate power to guide what is done with e-waste”*	• *“The challenge in our organisation that prevent the implementation of GIT is lack of knowledge or awareness of GIT and its benefits. hire qualified and experienced people to deal with issues relating to GIT implementation. support through finance and willingness to implement GIT”.* • *“Electronic waste is throwing or discarding of electronic devices which are no longer in use. Whereas GIT refers to a process of disposing computers related equipment in an environmentally friendly manner”*	• *“Electronic waste contains toxic chemicals which are not good for the humans as well as the environment. For example, when e-waste is dumped or scattered, when it rains toxic chemicals will be swamped into the river where water is being consumed by people and all living things”.* • *“Certified e-waste recycling”* • *“Give your e-waste to a certified e-waste recycler and that way you won’t be polluting the atmosphere and putting people’s lives in danger and protecting your personal information”.*
Source of influence **X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions	Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Companies"* • *"Because they have a lot of old electric and electronic devices which are deemed disposable"*	• *"Resale the unused equipment to employees or donate to the needy or recycling companies. The government and pressure from unions can ensure what is done with e-waste generated at our institution"*	• *"There is a lack of awareness and proper planning to execute the some of the proposed solutions of e-waste, that is GIT practices. Get skilled people from outside if you do not have them. Use the researcher to help and guide how to implement it".* *"Electronic waste entails all electrical and electronic components that are considered no longer useful to usage and are thrown away. On the other hand, GIT is solution to these problems in a way friendly to the environment".*	• *"Electronic waste can be dangerous to health and environment because they contain toxic chemicals. These chemicals can harm people, animals, plants, and the environment when they are burned or disposed carelessly".* • *"Donations and recycling"* • *"With recycling the e-waste could be used to produce other products. Recycling reduces cost, environmental pollution, and space occupation"*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimacy**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"The environment"* • *"Reduced environmental impact as a result of GIT"*	• *"My organisation must donate equipment to needy organisations. This will help needy organisations to gain skills in IT. Willingness to change from top management and pressure from the unions has control over what is to be done with e-waste in the organisation"*	• *"I think the challenges to implement GIT is cost. Our economy is slowly improving in every sector especially in the mist of "free education campaigns. The institution should outsource GIT implementation to private people".* • *"Electronic waste means getting rid of electronic devices or recycling of electronic appliances while GIT means considering how to protect the environment in relation to throwing away computer related products".*	• *"Damage to the atmosphere which leads to their toxic materials affecting land and sea. This leads to poor health of people, animals, and contaminated food. It may also cause air pollution problems".* • *"Donating and recycling"* • *"Certified recycler will know how to dispose them safely. When you donate you help "people who do not have the equipment and you also provide access to IT"*

Source of influence	X5	Motivation	Control	Expertise	Legitimacy
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful "GIT" initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Environment and the community"* • *"Green information technology minimises the negative impact of IT operations on the environment by designing a way of disposing computer related products in a friendly manner"*	• *"They should sell unwanted IT equipment to authorised collectors or recyclers. Involvement from management can direct what is to be done with e-waste"*	• *"The cost of implementing GIT initiative is the major challenge in the organisation. Institution should use their human resource to implement GIT. They have researcher that can direct how GIT is implemented".* • *"Electronic waste describes discarded electronic or electrical devices. GIT is the practice of environmentally sustainable computing".*	• *"Toxic materials from e-waste seep into groundwater affecting both land and sea animals. When e-waste is warmed up, toxic chemicals are released into the air damaging the atmosphere?"* • *"Reuse"* • *"Reuse extends the life of existing equipment, which somehow slows the accumulation of e-waste"*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimacy**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"I think is the business and the environment".* • *"Businesses that practice GIT will save on electricity costs and secondly GIT has a positive impact on the environment. For example, we will not drink water contaminated with toxins from e-waste components".*	• *"They should sell them to us or donate to needy non-governmental organisations. Government has the power to tell what institutions should do with their e-waste".*	• *"I think is not practiced because they sell us computers that work for short time. They sold to us problems because you do not know what to do with it?".* • *"Electronic waste is the unwanted electronic or electric equipment by the owner. Green information technology is practicing ways to minimise or eliminate negative impact of e-waste to the environment" .*	• *"On health e-waste toxic causes illness that are sometimes irreversible. With regards to the environment when e-waste seeped into soil it contaminates plants and the living organs in that soil"* • *"I think reduce and recycling".* • *"With reduce I mean stop buying unnecessary IT equipment and making sure we buy products that are friendly to the environment. We should recycle e-waste to produce other products from recycled materials"*
Source of influence	**X7**	**Motivation**	**Control**	**Expertise**	**Legitimacy**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses	• *"Companies that sell IT products that are friendly to the environment".* • *"People are gradually becoming aware of the impact of e-waste to the environment. Therefore, they will eventually buy products that are friendly to the environment. Companies that sell environmentally friendly products will make money".*	• *"They sell the computers that they write-off to us staff members at a cheap price. Most of that equipment is very old".*	• *"I am not sure. There is no information in the public from my organisation on what do to with e-waste. There is e-waste lying around in the offices and laboratories. Our institution should hire people with skills to implement GIT. Not only that but the management should invest in proper e-waste management programs".* • *"Electronic waste is the electronic or electrical equipment that is not needed by the owner while GIT for me is how can we get rid of e-waste without harm to the environment".*	• *"Ha! e-waste contains toxins that can harm or kill. The fumes of burning waste can bring sicknesses to humans and contribute to carbon dioxide footprint".* • *"I think is reduce, reuse and recycle as I learnt from the digital story presented".* • *"When you reduce you stop producing e-waste. reuse helps with buying products that can be reused rather than buying new ones that contribute to e-waste. recycle helps producing other new products from materials already in the market"*

The participants' responses, as they relate to the four CSH sources of influence are discussed next.

8.5.2.1 Motivation

Question(s): Who gains from GIT, and in what ways?

In the diagnostic phase at least, most participants struggled to respond adequately to the question. They overwhelmingly responded that they "*don't know".* However, after seeing the digital story, X1 said, "*People and animals. technology used is environmentally friendly which reduces the climate change problems. . . companies that sell environmentally friendly products will make money*". These are findings that support the literature that digital storytelling could build awareness (Yang, Ng & Su, 2023:2). When people acknowledge effective management, they are more willing to buy green products. Those in the business of producing green products will make money. The digital story has once again demonstrated its power to build awareness for these participants.

8.5.2.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

According to X3, "*give to scrap yards*". "*Send it together with municipal rubbish*", X4 advised (Table 6-7). In this phase, they reported in this manner. However, after viewing the digital story, X3 felt that the decision to handle e-waste should be left to those in power at HEIs and the government as the main funder of public HEIs. X3 further advocated that e-waste that is functional should be donated. X4 also supported giving to the needy. Currently, municipalities cannot be trusted with the disposal of this waste as they struggle with other solid waste in landfill sites (Abubakar *et al.*, 2022:6).

8.5.2.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful "*GIT*" initiative's implementation? What do the phrases e-waste and GIT mean to you?

When asked about GIT practice at the institution during diagnostic phase, X2 replied, "*Surely, I cannot give you the answer. I don't know really*". However, after viewing the story, X2 remarked, "*The challenge in our organisation . . . is lack of knowledge or awareness of GIT and its benefits*." When asked about the term e-waste, P4 reported that "*For me waste is something not needed, with e-waste not sure, GIT because it has the word green, I think is what is good for us*". Although the participants are still in need of more education, there is light at the end of the tunnel in the context about awareness about the dangers of this waste and the remedies provided by GIT.

8.5.2.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which *e-waste* disposal techniques do you believe to be environmentally friendly?

Here, X4 replied, "*Damage to the atmosphere"*. X4 further said, "*Certified recycler . . . dispose them safely*". In this phase, X2 said, "*Give e-waste to a certified recycler*". The digital story seemed to create awareness in the participants.

According to (Gibertonia *et al.*, 2016:377), **specifying learning** entails identifying overall findings as the outcome of action. The specifying learning phase does not begin and end with the evaluation phase, but rather encompasses all phases beginning with diagnosis and ending with evaluation. Before the intervention (digital story), younger participants (in terms of age) displayed a lower level of awareness compared to older participants. Those who had some understanding of GIT and e-waste acquired it through self-reading or attendance at workshops held off campus. This pattern led the researcher to propose that e-waste and GIT practices be taught in HEI programmes or made a requirement for recruiting ITTs in the future.

8.6 TVET college (case 2)

Critical systems heuristics framework supplemented with content analysis are used in the evaluation phase.

8.6.1 Themes generated (interviews)

In the following section(s) content analysis was used to generate themes and code frequencies. The generated themes are: (i) methods of disposal, (ii) effect on the biosphere and health, (iii) rewards and recipients, (iv) e-waste management at the institutional level, (v) difficulties in implementing GIT practices, and (vi) information technology that is environmentally friendly.

8.6.1.1 Theme 1: Methods of disposal

After viewing the digital story, five participants opted for recycling. Donating was viewed as a less effective method. Municipal garbage bins and putting into the ground were ranked the highest. After the digital story, participants chose recycling, donating, and repairing; that is, the 3P's of effective management of this waste (Ghulam & Abushammala, 2023:7). Table 8-8 shows frequency of code incidence in electronic waste disposal methods related to theme 1.

Table 8-8: Frequency of code incidence in electronic waste disposal methods

Participant / Content	X1	X2	X3	X4	X5	X6	Cumulative
Electronic waste emits poisonous fumes	1	1	1	1	1	1	6

8.6.1.2 Theme 2: Damaging effects on the biosphere and human well-being

Awareness triumphs over the consequences of the incorrect handling of e-waste. The participants now know what e-waste has in store for us. There are *good, bad and the ugly* sides to e-waste. In diagnostic phase, X1 was not certain about consequences of this waste on the biosphere and human well-being. The story created awareness for X1. Hazardous substances found in electronic waste can cause hearing loss and other serious health problems that may cause death (Liu, Huo, Xu, Wei, Wu, Wu & Xu, 2018:621; Parvez *et al.*, 2021:905). Table 8-9 list frequency codes for comprehension of electronic waste negative outcomes related to theme 2.

Table 8-9: Frequency codes for comprehension of electronic waste's negative outcomes

Participant / Content	X1	X2	X3	X4	X5	X6	Cumulative
Electronic waste emits poisonous fumes	1	1	1	1	1	1	6

8.6.1.3 Theme 3: Benefits and beneficiaries

In the diagnostic phase, it emerged that X1, X2 and X4 were unable to identify the benefits and beneficiaries of GIT. Following the digital story, all participants were cognisant of the advantages and beneficiaries of this approach (GIT) recommended for the effective treatment and disposal of this waste. Numerous entities will benefit from putting GIT first in our communities and organisations. The literature advocates that people, communities, green product producers and the ecosystem all benefit (Shaikh, Thomas & Zuhair, 2020:1). People should also break away from prioritising the price and other functionalities of this equipment over the cost to the environment and human well-being (Ichikowitz & Hattingh, 2020:47; Maan & Dhillon, 2013:162; Mohamad, Thoo & Huam, 2022:2). Table 8-10 shows frequency of occurrence for codes on recipients and advantages related to theme 3.

Table 8-10: Frequency of occurrence for codes on recipients and advantages

Content \ Participant	X1	X2	X3	X4	X5	X6	Cumulative
Recipients	1	1	1	1	1	1	6
Advantages	1	1	1	1	1	1	6

8.6.1.4 Theme 4: Institutional management

All the participants reported that their institution does not manage e-waste well. X1 said that *"there is no control on when to switch on/off in laboratories and offices"*. This is one of the reasons why one may deduce that disposal procedures are not effectively managed. Energy (electricity) contributes to the carbon footprint that ultimately leads to climate change (environmental issues). P3 said, *"you will often see old computer parts such as keyboards lying all over the campus*". According to P5, "*there are no specific locations where electronic garbage may be dropped off*." These participants never disclose such information about their institution, once again a clear indication that the digital story intervention is working for these participants. Table 8-11 list code incidence rates for electronic waste disposal procedures related to theme 4.

Table 8-11: Code incidence rates for electronic waste disposal procedures

Content \ Participant	X1	X2	X3	X4	X5	X6	Cumulative
Insufficiently	1	1	1	1	1	1	6
Moderately	0	0	0	0	0	0	0
Sufficiently	0	0	0	0	0	0	0

8.6.1.5 Theme 5: Implementation challenges

Remarks, such as immediate expenses and knowledge deficiency are common to one of the previous cases (university of technology). Because there is a lack of awareness of how bad e-waste is, implementation is perceived as a challenge. All the reasons put forth by the participants are supported by the literature (Ribeiro *et al.*, 2021:7). Most participants are now making informed decisions, based on the intervention (digital story). Table 8-12 shows frequency codes for obstacles in implementing green computing related to theme 5.

Table 8-12: Frequency codes for obstacles in implementing green computing

Content \ Participant	X1	X2	X3	X4	X5	X6	Cumulative
Education	1	1	1	1	1	1	6
Fear to accept change	1	1	1	0	1	1	5
Monetary injection	1	1	0	0	0	0	2

8.6.1.6 Theme 6: Terminology

Participants are all confidently able to describe what e-waste and GIT are. X2 said that: *"Electronic garbage is made up of gadgets that people or organizations no longer need. The environmentally and health-safe solution to the e-waste problem is green information technology."* X1 said that "*discarded electrical or electronic equipment is known as electronic trash"*. According to X1, "*discarded electrical or electronic equipment is known as electronic trash."* When questioned about GIT, X1 responded*, "green information technology is the utilization of computer resources in an ecologically sustainable manner*". Prior to viewing the digital story, they could not define or explain either of these phrases. Table 8-13 shows frequency of occurrence of the phrases electronic waste and green computing.

Table 8-13: Frequency of occurrence of the phrases *electronic waste* and *green computing*

Content \ Participant	X1	X2	X3	X4	X5	X6	Cumulative
I am familiar with GIT and e-waste	1	1	1	1	1	1	6

8.6.2 Mapping CSH (questions)

Table 8-14 shows a summary of participants' responses during the evaluation phase of TVET (case 2).

Table 8-14: Participants' responses (evaluation)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Manufacturers benefit by producing environmentally friendly products".* • *"Information technology departments can benefit by using options such as virtualisation"*	• *"Donate them if they are still in good working condition, otherwise recycle with certified e-waste recycler. I think students and employees have power to ensure that something is done about e-waste in the organisation"*	• *"Green information technology is not practiced because sometimes computers are left running at night in the offices and students' laboratories. I think the challenges to GIT include initial costs, lack of motivation reluctant to change and lack of support by stakeholders such as the management".* • *"Electronic waste is the disposal of electronic devices with intention of being reused. GIT is the efficient way of using computer resources"*	• *"Some of the effects of e-waste includes air pollution, water pollution and soil pollution".* • *"Giving e-waste to certified recycler, giving back to electronic companies and drop off points. All these options will ensure safety".* • *"They all assist in reducing e-waste in a way that is friendly to the environment"*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment and the community"* • *"Green information technology will reduce environmental hazards. The community will be free from health hazards caused by e-waste"*	• *"I think they should practice GIT to dispose of e-waste. for example, recycle the waste and reuse. Top management have the power to make sure that e-waste is dealt with in a way friendly to the environment"*	• *"Green information technology is not practiced because sometimes computers are left running at night in the offices and students' laboratories. I think the challenges to GIT include initial costs, lack of motivation reluctant to change and lack of management support. Qualified people are needed to implement GIT"*	• *"Electronic waste can contaminate water in the rivers and groundwater thereby affecting health of the species in rivers and humans".* • *"Formal recycling and reuse of e-waste"* • *"They [formal recycling and reuse] all reduce the problem of e-waste. when we reuse do not buy new products that eventually contribute to e-waste. secondly when we recycle, we can produce other new products from the recycled materials"*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The companies that produces environmentally friendly products".* • *"People and organisations will prefer their products once they are aware of their positive impact to the environment and health"*	• *"They should donate the equipment that is still working, otherwise recycle it with certified recyclers. our institution is a public organisation, it is depended on the government for funding, for example. Therefore, only the government has the power to ensure that e-waste is managed in a manner friendly to the environment"*	• *"I am not sure, but you will see old printers, keyboards around the campus. Sometimes old equipment is dropped in general waste dustbins. For institution to run a successful GIT program they must consult with government departments that handles environmental issues for support"* • *"Electronic waste are old electronic or electric devices that are no longer wanted by their owners. On the other hand, GIT are methods that are used to remove this e-waste in a way that is friendly to the environment"*	• *"Electronic waste is hazardous because it has serious health implications. Sometimes it can cause irreversible health issues. Damage skin, liver and other human organs"* • *"Formal recycling and donating to the needy. For example, donate to nongovernmental organisations equipment you no longer need but working".* • *"With donations you help the less fortunate. When you recycle you can produce new products from the recycled materials"*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment will benefit from GIT".* • *"With GIT you can reduce the impact of e-waste to the environment. For example, avoid water contamination from e-waste in landfills"*	• *"The institution should sale it to the employees and students if equipment is still working or donate. The community of our institution has the power to control what is done with e-waste. it is a collective task".*	• *"I am not sure that they are aware of the benefits of GIT. For example, computers are left switched on the whole night in students' laboratories and offices. Our institution is of higher learning; therefore, they have people who can research on how GIT is and how is implemented. Top management should also show willingness to GIT".* • *"Electronic waste are devices that are obsolete and unwanted by the organisations and individuals. I think GIT helps with ways that reduce damage of e-waste to the environment"*	• *"When e-waste is dropped in landfills it can contaminate underground water. In the landfills when people burn the general waste, the fumes of e-waste could be inhaled. The inhaled fumes cause health problems such as cancers and skin problems".* • *"I think there is no best way to deal with problem of e-waste unless we stop producing it. for example, formal recycling still poses health hazards".* • *"When you stop producing products that are safe to the environment. In that way you will be reducing e-waste"*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"Companies that produces environmentally friendly equipment".* • *"People will prefer their products when they are aware of their positive implications to the environment. Having said that these companies will make huge profits"*	• *"If the condition of the device is good, they should donate to local schools and non-governmental organisations. The line managers and the top management has the power to control what must be done with the generated e-waste".*	• *"I am not sure because there is no dedicated drop off points for e-waste around the campus. I think they are not aware, or they are reluctant to start practicing GIT. A successful GIT initiative will need qualified staff and skilled people".* • *"Electronic waste is electronic or electrical equipment that has no longer value to the owner. On the other hand, GIT are methods that get rid of e-waste in a way that does not harm the environment".*	• *"Electronic waste when seeped into soil it can damage the soil ready for crop growing. The fumes of e-waste when inhaled can cause health problems".* • *"The best method is to stop producing the equipment that is harmful to the environment. Secondly, recycle the e-waste to produce new products from the recycled materials".* • *"When you reduce by not buying equipment that will eventually harm the environment, you stop e-waste. With formal recycling you minimise or stop toxic fumes negative effects on the environment and people including recycling employees. The recycled materials can then produce other products".*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses	• *"Communities and companies that sell environmentally friendly computing equipment".* • *"Communities' health will improve, and more jobs will be created. Equipment that is friendly to the environment does not pose health hazards. Companies that produce these products will rake in huge profits once people are aware of their benefits to the environment and health".*	• *"Donate working equipment and sell the non-working equipment to certified recyclers. They can donate to local schools and sell to staff at a very low price. The government as the main funder and law maker has the power to control what must be done with e-waste in HEIs".*	• *"I don't think my organisation is aware of GIT. We don't talk about it as colleagues. There are simple ways to get started with GIT. For example, create awareness through posters around the campus. Our institution should work together with private people on e-waste if they want to implement it. Management should be willing to support the initiative".* • *"Electronic waste is discarded electrical or electronic devices. These devices are sometimes destined for recycling through material recovery, discarded in landfills where they are danger to the environment. Green information technology is the use of computer resources in a way that is sustainable to the environment".*	• *"When we do not sustain the environment, the future generation will not benefit from it. e-waste contaminates water, air and soil thereby creating health hazards. These hazards include some of the irreversible organ damages".* • *"Reducing waste and recycle the e-waste that already exists".* • *"When you reduce you do not generate a new e-waste. when you recycle in way friendly to the environment you safe the raw materials"*

The participants' responses, as they relate to the four CSH sources of influence are discussed next.

8.6.2.1 Motivation

Question(s): Who gains from GIT, and in what ways?

X2 responded, "*I am not sure, as GIT is a new phrase at all. It probably conserves computer energy"* in the diagnostic phase. After the digital story, X2 remarked that "*the environment and the community*" benefit (Table 8-14). Green information technology encompasses much more than just electricity. It is all about green disposal, green use, green manufacturing, and designs to name but a few (Pedrycz, 2021:1). X4 remarked that "*the environment*" benefits through *". . . not to pollute the earth*". In general, GIT strives to preserve the use of materials for future generations.

8.6.2.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

Studies inform us that little is done at HEIs to implement successful practices to curb the challenges of e-waste (Samoeia, Moturib & Orwa, 2021:393). When asked about this in the diagnostic phase, participants responded as follows: X2 said that "*maybe, I don't know*", X1 replied, "*I am not sure really*" about what should be done with it, and P6 said, "*sell or . . . recycle*". Regulated recycling is encouraged, as it minimises the effects of e-waste. After diagnosis in the evaluation phase, X2 stated "*The environment and the community*." These are clear indications that the digital story works. The story seemed to have triggered awareness in X1, X3 and X2 (Table 8-14).

8.6.2.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of successful GIT initiative's implementation? What the phrases e-waste and GIT mean to you?

Diagnostic phase responses from the following participants (X1, X2, and X4) are as follows: X1 stated:

> *"I cannot comment due to lack of knowing what GIT is. Electronic waste and GIT are new terms for me. . .. sometimes see topics on those but ignore to read. Maybe I am oblivious, but nothing has changed since before joining this institution."*

X2 reported, "*Electronic waste is same as waste that nobody wants and GIT . . . are said to save electricity*". X4 remarked, "*Poorly because no one is talking about it*". After the digital story, X1 remarked, "*Green information technology is not practiced . . . computers are left running at night . . .* ". X1 further reported that "*challenges include initial costs, lack of motivation . . .*" The remarks after viewing story indicate that knowledge has been imparted to these participants. X4 said, "*inhaled fumes cause health problems such as cancers and skin problems* ". X4 further iterated that to minimise e-waste we must "*stop producing it*".

8.6.2.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

In the diagnostic phase, the following participants (X 5 and 6) battled with adequate responses to the questions. X6 reported, "*Pollute earth. I think the best is to burn it. when you stop producing more and burn old ones you reduce the impact of waste . . .".* X6 is partly correct. However, the impact of the digital story is felt through participants' responses. Burning e-waste pollutes the biosphere. It is correct to stop producing more waste, but not through burning obsolete items. "*The fumes can cause respiratory illnesses",* reported X3. Toxic emissions are harmful to human well-being. Putting waste into bins or making municipalities responsible for effectively handling e-waste is not an option. Municipalities struggle with the disposal of other solid waste in landfill sites (Samoeia *et al.*, 2021:393). By giving municipalities, the task will not help, keeping in mind the current procedures they employ to dispose of general waste. *". . . stop producing the equipment that is harmful to the environment*", said X5. We cannot stop producing electronic items, as our lives are dependent on them. We should rather stop exploiting the natural resources by recycling the waste and producing new equipment or repurposing the existing abandoned functional ones (Ghulam & Abushammala, 2023:2).

It ultimately comes down to **interpreting learning** as the general conclusion that results from a particular activity (Gibertonia *et al*., 2016:377; Shu, 2022:46; Susman & Evered, 1978:588). When participants learned how toxic and harmful e-waste is, they were astounded and shocked. They held the opinion that only plastic cable coverings decompose, and that the remaining components might be buried in the ground and ultimately decay. After viewing the digital story, they concluded that they should practice GIT. The participants were enthusiastic and took part in the entire study. At no point did anyone decide to leave the study. Students, on the other hand, were hesitant to provide photographs of how e-waste is handled on campus. Most participants kept their working cell phones and computer parts in the hostels. Some promised to make donations to students without smartphones or to family members when they return home for academic breaks. Only after watching the digital narrative did they discover this.

8.7 TVET (case 3)

Critical systems heuristics framework supplemented with content analysis are used in the evaluation phase.

8.7.1 Themes generated (interviews)

In the following section(s) content analysis was used to generate themes and code frequencies. The generated themes are: (i) disposal, (ii) awareness.

8.7.1.1 Theme 1: Disposal process

All participants chose the effective methods to tackle issues of e-waste; that is, recycling, donating and reducing. One way to reduce is to minimise the reliance on the use of raw materials to produce new products. Already existing products can be channelled to different functions as opposed to the intended use when they were first produced. Prior to viewing the digital story, participants chose burning as an effective method (X7, X9 and X11), keeping obsolete items in allocated spaces, such as at home or at work (X3, X8, X10, X11, and X13). The story indeed guided all the participants in the right direction. Table 8-15 shows frequency codes for routine electronic waste control practices related to theme 1.

Table 8-15: Frequency codes for routine electronic waste control practices

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Discard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Give, recover, cut down on, or trade	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Keep at dwelling locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

8.7.1.2 Theme 2: Awareness

Ahead of this current phase (diagnostic phase), the rest of participants were in the dark about the disastrous implications of poorly handled e-waste (Table 8-16). In the diagnostic phase, their remarks included "... *really, I am not sure, tell me please!"* X2 replied. However, after exposure to the digital story, they all seemed to have realised the importance of discarding e-waste responsibly. In that phase (diagnostic), detrimental effects were all about cleanliness. Some of the remarks made then were the following: "*It's not good to be surrounded by trash you made yourself*." said X5. Table 8-16 shows code frequency of occurrence for knowing the effects of electronic waste related to theme 2.

Table 8-16: Code's frequency of occurrence for knowing the effects of electronic waste

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	Cumulative
Not-aware	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aware	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14

8.7.2 Mapping CSH (questions)

Table 8-17 shows a summary of participants' responses during the evaluation phase of TVET (case 3).

Table 8-17: Participants' responses (evaluation)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Community that collect and sell to formal recyclers".* • *"Making money from selling the collected e-waste"*	• *"Donate to the needy and sell the non-working ones"*	• *"Green information technology is not practiced because sometimes computers are left running at night in our laboratories, skilled people are required to handle the problem of e-waste".* • *"Electronic waste should not be left unattended as it is dangerous to the environment. GIT is all about ways to minimise detrimental effects of e-waste to the environment"*	• *"It pollutes water and food we grow for consumption".* • *"The story taught me we should take to authorised recyclers".* • *"Authorised recycling is safer than informal recycling"*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Environment and the recycling or 'scrap pickers' people"* • *"Trees will grow and be untouched and help with air we breathe; recyclers and 'scrap collectors will make money"*	• *"Top management have the power to make sure that e-waste is dealt with in a way friendly to the environment"*	• *"I think it is not practiced because no one talks about GIT".* • *"Electronic waste is unwanted electronic devices by the organisation or individuals. Green information technology refers to the ways that help with managing it wisely"*	• *"Electronic waste can contaminate water in the rivers and groundwater thereby affecting health of the species in rivers and humans".* • *"Formal recycling and reuse of e-waste"* • *"They all reduce the problem of e-waste. when we reuse, we don't abuse raw materials secondly when we recycle, we can produce other new products from the recycled materials"*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"The companies that produces GIT products".* • *"Consumers will prefer their products that are safe to their health, so those producers will make money over time"*	• *"They should donate the equipment that is still working, otherwise recycle it with certified recyclers"*	• *"I think in a bad way because you will see old printers, keyboards around the campus. Sometimes old equipment is dropped in general waste dustbins".* • *"Electronic waste are old electronic or electric devices that are no longer wanted by their owners. On the other hand, GIT are methods that are used to minimise impact of e-waste to the environment"*	• *"Electronic waste is hazardous because it has serious health implications such as asthma".* • *"Formal recycling and donating to the needy".* • *"Helping the less fortunate through donations is the right thing to do. When you recycle you help others to put bread on their tables"*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"The environment will benefit from GIT".* • *"With GIT you can reduce the impact of e-waste to the environment"*	• *"They should sale it to the employees and students if equipment is still working or donate it"*	• *"Our institution is of higher education or learning; therefore, they have people who are able to research on how GIT is and how is implemented".* • *"Electronic waste are devices that are old and unwanted by the organisations and individuals. I think GIT helps with ways that reduce damage of e-waste to the environment and human life."*	• *"When e-waste fumes are health hazards and it pollutes the water sources, etc."* • *"I think stopping producing it is the best way".* • *"When you stop producing products that are not safe you reduce impact on environment and health".*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Companies that produces green computing devices".* • *"People will prefer from buy safe products, eventually companies will rake in profits".*	• *"If the condition of the device is good, they should donate to local schools and us students".*	• *"I think is managed not in a good way. For example, there is no marked drop off points for e-waste around the campus".* • *"Electronic waste is electronic or electrical equipment that has no longer value to the owner. On the other hand, green information technology are ways that clean e-waste in a safe way to the environment".*	• *"Electronic waste has the potential to contaminate crops and the water we drink when not managed properly".* • *"It is for producers or manufacturers to stop producing the equipment that is harmful to the environment".* • *"When we only produce environmentally friendly equipment the e-waste impact will be reduced greatly to the environment and life"*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"Communities and companies that does recycling".* • *"Communities' health will improve, and more jobs will be created. Companies that produce these products will rake in huge profits".*	• *"Donate working equipment and sell the non-working equipment to authorised recyclers".*	• *"No one talks about it as including the lectures".* • *"Electronic waste is something that uses electricity and not wanted by the owner for various reasons. Green information technology helps clean the environment from e-waste bad impact".*	• *"Electronic waste has the potential to kill life and leave unhealthy environment for future generations".* • *"Reducing waste and recycle the e-waste that already exists".* • *"When you reduce you do not create new e-waste, when you recycle in way friendly to the environment you save the environment materials and make money".*
Source of influence	**X7**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT"? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"I think the environment benefits".* • *"By reducing carbon footprint that affect climate with devastating outcomes to the environment and humans".*	• *"I think they should donate the ones that are still working but not needed by them. Secondly send non-functional ones for recycling".*	• *"No one is talking about GIT. even the top management or teachers during the lecture they are silent on the topic. Hence, I believe GIT is not managed properly".* • *"Electronic waste is unwanted IT equipment by the owner and GIT is a way on how to handle e-waste in a manner positive to the environment. I mean not destroying the environment".*	• *"Contributes to carbon emissions when burnt and the fumes are dangerous to human health".* • *"Donation and recycling"* • *"When you give to the needy you remove the need to buy new products. Again, when you recycle you reserve raw materials".*
Source of influence	**X8**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Society benefits from GIT".* • *"More jobs will be created for those who are qualified and skilled in GIT".*	• *"Repair the ones that are not working in order to avoid buying ones that will eventually contribute to e-waste".*	• *"I don't think is practiced because you sometimes encounter IT equipment parts left unattended or dumped in the general rubbish bins".* • *"Information technology equipment or devices that have no value to their owners due to non-functionality or other reasons. Green information technologies are methods dedicated to dispose of e-waste in a way that is friendly to the environment".*	• *"Contaminate soil, water and air when managed improperly. Contaminated environment is dangerous to human health as humans, plants and animals".* • *"Donating and not landfilling e-waste or combine it with municipal general waste as this waste end up in landfills".* • *"When you don't landfill you stop leaking of e-waste metals that eventually contaminate the environment"*
Source of influence	**X9**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which 'e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment and the community benefit from it".* • *"Health impacts of e-waste on people is reduced or eliminated and environment can be sustainable for the next generations".*	• *"Give the device to students who are less fortunate or cannot afford to buy these gadgets. If the equipment is not working send it for recycling".*	• *"I am not sure as there are currently no activities related to practice of GIT".* • *"Electronic waste is retired IT equipment that its components have both monetary value when sold and harmful to the environment when not properly handled or managed. Green information technology helps us with ways to reduce or eliminate hazards of e-waste to the environment".*	• *"Electronic waste toxic metals can leak into soil and enter human food chain causing harmful health effects".* • *"Donate to the less fortunate such as schools and non-governmental organisation or sell to recyclers".* • *"When you recycle you save natural resources, and you can use the recycled materials to build other products. When you donate you promote access to IT use"*
Source of influence	**X10**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		*"The environment and the society at large benefit".* *"Energy consumption and pollution will be reduced, and people can sell unwanted IT equipment to make extra cash".*	*"Send e-waste to professionals who deals with e-waste. the working unwanted devices should be given to students and surrounding schools and other non-governmental organisations".*	*"We are not told what to do with IT equipment we do not need. You will always see abandoned cell phones and batteries around the campus".* *"Green information technology helps manufacturers build equipment that is not harmful to the environment, humans, and other living things. Electronic waste is any IT equipment or electric that is no longer wanted by the owner".*	*"The leaking waste from e-waste metals can cause water or soil pollution. When contaminated water is consumed it can be harmful to humans, animals, and plants. This is what I learnt from the digital story".* *"Buy when necessary and buy only IT equipment friendly to the environment or recycle".* *"When you buy, when necessary, you reduce e-waste. Secondly buying friendly IT equipment to the environment you promote sustainability"*
Source of influence	**X11**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

Responses		• *"Companies that sell or produce green IT equipment and the environment".* • *"People will buy from those companies once they are aware of how green IT products benefit their lives. On the other hand, environment will benefit as it will no longer be subjected to harmful materials that build IT equipment".*	• *"Donate to the community since institutions should engage in community projects. Otherwise recycle".*	• *"No one talks about it. not even in are books or in lecturer halls".* • *"Anything of electronic or electricity that is no longer wanted by the owner for different reasons. On the other hand, I think GIT is group of methods that help in saving the environment from the effects of e-waste."*	• *"I think e-waste when burnt pollutes air, leaking pollutes soil and water. When people or animals drink polluted water or inhale polluted air, they get sick"* • *"Reduce e-waste by not buying without need. Secondly, we should repair or refurbish broken IT equipment".* • *"When you don't buy unnecessarily you reduce e-waste that will be generated by the newly bought equipment when it reaches end-of-life stage. Again, when you repair you reduce waste by fixing the equipment already bought"*
Source of influence	**X12**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses					
		• *"The producers or manufacturers of green IT equipment and people".* • *"The manufacturers will design sustainable IT devices that uses less power and reduces carbon emissions. People will benefit health wise as harmful materials will be reduced or eliminated in these products".*	• *"Give to the students who need them. When they are not working sell them to the recyclers or e-waste collectors".*	• *"In my institutions there are no campaigns about e-waste like other issues that affect the society such as 'gender violence'".* • *"Any equipment that uses electricity and is of electronic of which the owner needs no longer. Green information technology helps manufacturers to build IT equipment that is friendly to the environment".*	• *"Although it contains valuable metals it also includes harmful metals to health and environment. when harmful metals contaminate soil, it can spoil crops and soil ready for consumable plants?"* • *"Reduce, reuse or recycle as I learnt from the digital story".* • *"When you don't buy you reduce e-waste, when you reuse you also cut the need for new equipment. Lastly when you recycle you save natural resources by using the recycled ones to build other new products"*
Source of influence	**X13**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses		• *"The environment".* • *"Green information technology will help manufactures to use fewer natural resources for production of IT equipment".*	• *"It depends if not working they should repair or refurbish otherwise send for recycling. When equipment is working but not wanted, they better donate it to local schools or churches, etc.".*	• *"I am not sure, but the only thing that I am sure about is that no one is speaking about it".* • *"Electrical or electronic IT equipment that is not wanted anymore. GIT helps with ways to protect environment and use less raw materials when producing IT equipment".*	• *"When burnt it releases fumes that are detrimental to human health. The fumes also pollute air and contributes to climate change".* • *"I think we should not throw away or dispose in landfills instead we should go for recycling with registered recycler. Secondly stop buying IT equipment that is not friendly to the environment".* • *"When we don't landfill there will be no leaking of e-waste metals into soil or water"*
Source of influence	**X14**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

Responses	• *"Environment and human health"* • *"The environment will be reserved for the next generation as it will no longer be affected by the harmful effects of e-waste. People health will no longer be subjected to the harmful effects of e-waste".*	• *"They can organise competition among students and give it to students who performs well as presents. If not working sell to e-waste collectors".*	• *"I think is not practised, because you will always see cell phone components I general municipality waste. I learnt that it is wrong to mix these types of waste after watching the digital story".* • *"Electronic waste is something that is not needed, who need waste? Now the e-part refers to waste of electric or electronic. Green information technology helps us with ways to get rid of the waste produced by electronic or electrical devices in a way friendly to the environment".*	• *"Electronic waste can leak harmful materials that could possibly mix with consumable water by animals and humans thereby affecting wellbeing".* • *"We should not mix the general waste with e-waste. Usually, general waste ends up in landfills. Secondly instead of buying new products we must repair or refurbish the non-working equipment".* • *"When we stop buying, we save the natural resources. Secondly if we don't mix with general waste there won't be leaking of materials into the environment"*

The participants' responses as they correspond to the four CSH sources of influence are discussed next.

8.7.2.1 Motivation

Question(s): Who gains from GIT, and in what ways?

These are some of the participants' recorded remarks in the diagnosis. X1 reported that "*Scrap pickers or collectors. They make cash for families*". "*The people. We will save trees that shade us,* said X2. X4 remarked that "*It is first time to hear about the term GIT. . .. word GIT has green, I think land especially trees or nature will benefit*". At this point, the participants seemed to have a low level of knowledge and understanding about GIT. Saving trees is not only the focal point of GIT. Green information technology encompasses a whole number of things. It spans green disposal, manufacturing and design and includes usage. However, after viewing the digital story, the findings showed the improvement in terms of knowledge and understanding on the matter of GIT. X1 said, "*Community that collect and sell to formal recyclers* ". Now X1 is able to differentiate types of recycling. X1 is aware that informal recycling is not recommended. This could be deduced from X1's remarks after the digital story: "*The environment will benefit from GIT".*

8.7.2.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

X9 and X12 shared the same sentiments in diagnosis when they said that e-waste should be repurposed. X9 explained. "*Save some . . .for us to learn how to do repairs*", said X12. The repurposing of this waste is a good idea, and preferable to engaging in unsafe disposal procedures. Putting e-waste in dustbins of leaving it out to be collected with household garbage was again mentioned in this instance. Both options fall under the ineffective procedures for dealing with e-waste. However, X2 and X3 who suggested the former methods said the following after viewing the digital story. P2 said, "*Top management have the power*. . .". Indeed, execution of effective management of e-waste ultimately rests with those in power. Both participants show broader understanding and knowledge of what needs to be done after exposure to the digital story. The story has made a degree of sense to the participants regarding the effective management of e-waste disposal. X9 reported that "*Give the device to students who are less fortunate . . . if the equipment is not working send it for recycling*".

8.7.2.3 Expertise

Question(s): What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?

The participants felt that green information technology is not practised, as is evident from the following: X2 "*I think it is not practiced because no one talks about GIT*". "*No one talks about it as including the lectures*", said X6. X3 remarked, "*I think in a bad way because you will see old printers, keyboards around the campus*." of the fact that e-waste is lying around is a clear indication that there is either ignorance or a paucity of knowledge. X6's and X2's perspectives call for the introduction of a sustainability curriculum, especially in the context of the study issues which is lacking in most developing countries' literature (Nwachukwu, Nwachukwu, Ulo, Anyanwu, Okorondu, Acholonu & Ugochukwu, 2023:2). In the diagnostic phase, it was revealed that X1 and X5 struggled to define e-waste and GIT. However, they were both able to provide examples. X5 stated "*I think is managed not in a good way. . .".* Whereas P1 remarked that power is wasted by unnecessarily leaving computers and lights on night and day.

8.7.2.4 Legitimation

Question: How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?

The responses of some of the participants in the diagnostic phase were as follows: X2 remarked, "*Municipalities are equipped . . . to dispose it*." It is not true that municipalities could contain the solid waste. X3 also believed that municipalities can contain this type of waste effectively. The literature demonstrated that municipalities are faced with landfill challenges (Abubakar *et al.*, 2022:6). However, after intervention, P2 replied, "*Formal recycling and reuse are effective options*". "P5 replied, "*I think fumes are dangerous to humans.*" Though correct, e-waste's negative impact lies in the toxic substances it contains. The dangers are much more far reaching than mere emissions from cables. When it is buried, its lethal substances have the ability to contaminate the underground water. After viewing the digital story, their preconceived perspectives changed and P5 remarked, "*produce environmentally friendly equipment the e-waste impact will be reduced*". This is testimony of how the intervention worked for P5.

It ultimately comes down to **defining learning** as the general conclusion that results from a particular activity (Gibertonia *et al.*, 2016:377; Shu, 2022:46; Susman & Evered, 1978:588). After observing the digital story, participants felt inspired and content. They asked the researcher to bring their friends. They were informed that their friends could only be accepted in a "*new*" cycle, in which the diagnostic phase would be used to determine each participant's level of awareness. The "*new*" cycle was unable to manifest at this institution due to time constraints. According to the researcher, people who took part in this study would eventually emancipate all students on the campuses. The participants' motivation and desire to invite their peers after witnessing the digital story support this viewpoint. The participants were driven and took part during the full study.

At no point did anyone decide to leave the study. However, students were hesitant to present photographs of the campus's e-waste management practices.

8.8 University (case 4)

Critical systems heuristics framework supplemented with content analysis are used in the evaluation phase.

8.8.1 Themes generated (interviews)

In the following section(s) content analysis was used to generate themes and code frequencies. The generated themes are: (i) familiarity with the concepts of GIT and e-waste, (ii) discarding waste generated by electronics, (iii) comprehension of the harmful outcome of electronic waste, (iv) green information technology benefits and beneficiaries.

8.8.1.1 Theme 1: Terminology

The first step into understanding the importance of effective management of this type of e-waste and its counter strategies for its consequences is to know what GIT and e-waste are. Once you have this information in your arsenal you can then know how to protect yourself (well-being) and the biosphere (what keeps you alive). The participants appeared to be well-informed about explaining what the terms mean. Prior to watching the story, X3 said, *"Ï don't know exactly, but . . . the name has waste in it; therefore, e-waste is something you need no longer."* However, after viewing the digital story, X3 replied:

> *"Thanks to the intervention, e-waste is an equipment of electronic that the owner no longer wants. Regardless of the functionality. For the benefit of future generations as well as our own survival, green information technology includes techniques that assist us in protecting the environment."*

It is undeniable that digital stories may raise awareness, as Grant and Bolin (2016:44) claim. Table 8-18 display code frequency of occurrences on familiarity with concepts related to theme 1.

Table 8-18: Code frequency of occurrences on familiarity with concepts

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Electronic trash	1	1	1	1	1	1	1	1	1	1	1	11
Green computing	1	1	1	1	1	1	1	1	1	1	1	11

8.8.1.2 Theme 2: Disposal

Knowledge of typical effective methods to dispose of this type of waste as per participant is depicted in Table 8-19. Prior to watching the story, responses were wanting in terms of knowledge about effective measures to handle e-waste, for example, in the diagnostic phase, X1 stated, "*I prefer to store the gadgets that aren't in use at home because you never know when you might need them*." X4 responded, "*. throw it away or burn it!*". Neither burning it, throwing it away nor keeping it at home, is advisable as a sustainable strategy to manage electronic waste (Alziady & Enayah, 2019:4; Parvez *et al.*, 2021:905). Table 8-19 shows codes frequency of occurrences on discarding electronic waste related to theme 2.

Table 8-19: Codes frequency of occurrences on discarding electronic waste

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Dwelling place for storage	0	0	0	0	0	0	0	0	0	0	0	0
Clear it like normal litter	0	0	0	0	0	0	0	0	0	0	0	0
Minimize	1	1	1	1	1	1	1	1	1	1	1	11

8.8.1.3 Theme 3: Impact on humans and the biosphere

In the diagnostic phase, the following participants were doubtful about the harm caused by e-waste to well-being and the biosphere, in particular X1, X2, X3, X4, X7, X8, X9 and X10. However, subsequent to watching the digital story, they all displayed acknowledgement of the negative impact of e-waste. This is due to the benefit of the digital story in creating awareness as stated in the literature (Lohr, Raygoza Tapia, Valdez, Hassett, Gubrium, Fiddian-Green, Larkey, Sia & Wieland, 2022:2). Table 8-20 display code occurrence frequencies on damaging impacts of electronic waste related to theme 3.

Table 8-20: Code occurrence frequencies on damaging impacts of electronic waste

Participant / Content	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Aware	1	1	1	1	1	1	1	1	1	1	1	11

8.8.1.4 Theme 4: Gains and beneficiaries

After viewing the digital story, all the participants demonstrate knowledge of what GIT is. In the diagnostic phase, only X5, X6 and X11 were identified as having a "*sense*" of what GIT is. The intervention appeared to have created a realisation of what GIT is in the rest of the participants. The digital story is seen as having the potential to create awareness as claimed in the literature (Gillespie, 2022:3). Table 8-21 shows code incidence rates on gains and beneficiaries of green computing related to theme 4.

Table 8-21: Code incidence rates on gains and beneficiaries of green computing

Participant / Subject	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	Cumulative
Beneficiaries and gains of green computing	1	1	1	1	1	1	1	1	1	1	1	11

8.8.2 Mapping CSH (questions)

Table 8-17 shows a summary of participants' responses during the evaluation phase of university (case 4).

Table 8-22: Participants' responses (evaluation)

Source of influence	X1	Motivation	Control	Expertise	Legitimation
Questions		Who gains from *GIT*, and in what ways?	What should your organisation do with outdated *IT equipment*, regardless of how well it still functions?	What steps does your company take to implement *GIT*? If not, what obstacles stand in the way of a successful *GIT* initiative's implementation? What do the phrases *e-waste* and *GIT* mean to you?	How does *e-waste* affect the environment and human health? Which *e-waste* disposal techniques do you believe to be environmentally friendly?
Responses		• *"I think is the society and the retailers of IT equipment".* • *"Retailers will make more money when people and customers are aware of the benefits of GIT equipment. They will buy only GIT products. Society health will no longer be in harm's way because of e-waste"*	• *"They should donate or recycle the non-working equipment to authorised recyclers"*	• *"It is not practised well because often our laboratories or lecture halls computers are left running night long. Again, there is no one talking about GIT here".* • *"Quite easy, anything that is electronic or electrical and no longer wanted for various reasons by the owner"*	• *"Electronic waste makes you sick, therefore e-waste effects include harm to people's health and pollution to the environment".* • *"Donating and stopping producing more of what will become e-waste tomorrow".* • *"When you stop producing what will become e-waste soon, you stop further generation of e-waste. Secondly when you donate you extend the life of the equipment that could otherwise ended in a landfill"*
Source of influence	**X2**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a	How does e-waste affect the environment and human health?

				successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"The environment, recyclers and the community are the beneficiaries".* • *"We will be keeping the environment to be admired too by the coming generations, on the other hand the community's health will no longer be affected by the hazards brought by e-waste heavy metals"*	• *They should lookout for skilled people to advise how to deal with their IT equipment they don't need or e-waste"*	• *"It is not practiced because no one talks about GIT. Including our lecturer during class time"* • *"Waste of ee, I am joking but it is waste generated by electronic or electrical devices and no longer have value to the owner. GIT practices reduce impact of e-waste on the environment"*	• *"Electronic waste makes us sick or die. Fumes from it causes sickness and harm to the living beings".* • *"Recycle and repair of IT equipment. If it cannot be repaired or refurbished, we must send it for recycle".* • *"When you repair you extend the life of the equipment. With recycling you save resources by using the existing ones from e-waste to make new other products"*
Source of influence	**X3**	**Motivation**	**Control**	**Expertise**	**Legitimacy**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Community and retailers of GIT devices"* • *"People's health benefits from living in an environment free of e-waste. Retailers will make money once people are aware of the benefits of GIT equipment"*	• *"First have a policy on how they will deal with e-waste. If they are not sure how to develop one, they must seek help with skilled people from outside"*	• *"There are no campaigns on GIT here or any communication. Therefore, I think is not practised".* • *"After watching the digital story, I learnt that e-waste is any electronic or electrical equipment that is no longer needed by the owner regardless of the functional state of that device. Green information*	• *"Electronics waste when not managed properly makes people sick and could even cause death due to its toxic metals. It pollutes the environment".* • *"Reduce and repair or refurbish the IT equipment".* • *"When you reduce you stop from purchasing IT equipment that is not environmentally*

				technology is one way that ensure that we produce, use and dispose IT equipment in a way that is sustainable to the environment"	*friendly. Again, when you repair or refurbish you extend the life of the existing device"*
Source of influence	**X4**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Least the environment and the community"* • *"Our environment will be free from pollution cause by the e-waste. We will have clean water and fertile soil for crops. The community's health will improve"*	• *"My organisation should sale it to the employees and students if equipment is still working. Otherwise take it for recycling"*	• *"No one is talking about it. Even government people never visit us or send any communication about GIT. Hence, I believe it is not practised. Otherwise, there is a lack of communication for us to know as students about it".* • *"Thanks to the digital story, e-waste is any equipment of electronic or electrical that is not wanted by the owner anymore. Regardless of whether is working or not. Green information technology encompasses methods that helps us to respect the environment for the sake of the coming generations and our own survival too. We should not do anything that damages the environment when dealing with IT equipment"*	• *"It can pollute the water for household and the plants that we consume for food. Eventually we will get sick and even die".* • *"I think there is no best way to deal with problem of e-waste unless we stop producing it. for example, formal recycling still poses health hazards".* • *"With recycling you produce other products from the recycled materials instead of using new materials. By so doing you are saving the scarce natural resources. Secondly when you stop producing you stop accumulation of e-waste unless you purchase green IT products"*
Source of influence	**X5**	**Motivation**	**Control**	**Expertise**	**Legitimation**

Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?
Responses		• *"Companies that manufacture and sell green IT products and the environment".* • *"Consumers will eventually prefer green IT products once they are aware of their benefits".*	• *"They should donate to schools and non-governmental organisations. Alternatively, send it for recycling"*	• *"I am not sure because no one is talking about it".* • *"Electronic waste is electronic or electrical device no longer needed by the owner while GIT is a set of strategies to manage e-waste in a positive way to the environment".*	• *"The story taught me that e-waste has the potential to pollute the earth and could kill".* • *"Recycling in a safe environment and reuse"* • *"When you reuse you use the equipment already have and recycling in a controlled environment is safe than one done informally"*
Source of influence	**X6**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Society and the environment".* • *"With GIT you don't need materials that are toxic to the environment to manufacture IT equipment as it is the case now. On the other hand, an environment free from toxic of e-waste benefit the community health".*	• *"Repair the broken ones and donate the functional devices to the local community projects and schools".*	• *"I don't think my organisation is aware of GIT. We don't talk about it among us as students".* • *"Electronic waste is discarded electrical or electronic equipment; with GIT I forgot what the story taught me".*	• *"Electronic waste when it is burned it releases toxic fumes that causes sicknesses to living things".* • *"I think first people should be made aware of e-waste dangers. Once they are aware they will then dispose e-waste safely"* • *"When you are aware of e-waste dangers you will only*

					• *use methods safe to the environment and health"*
Source of influence	**X7**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Ï think is the environment and human health as I learnt from the story".* • *"Environment will be sustainable and human health will not suffer effects of e-waste".*	• *"I think they should give the working equipment to needy people and organisation within the community".*	• *"What I know there are bins for general waste, but with e-waste no one is talking about it".* • *"I now know that e-waste is any electronic or electrical equipment that is no longer needed by the owner, while GIT is a set of ways to be used to produce and dispose this equipment in a way that is not harmful to the living things health or the environment".*	• *"Electronic waste is harmful to the health of living things and the plants. It causes reversible and non-reversible health problems".* • *"I would say recycling and donation are the safest ways".* • *"When you donate you stop buying and you provide access to IT for the needy. When recycle you preserve raw materials"*
Source of influence	**X8**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Community and the retailers of GIT products and manufacturers".* • *"People can sell the e-waste to collector and make money. Their health will be*	• *"Sell the non-working equipment to the e-waste collectors or recyclers and give the working ones to the students who performs well in their studies".*	• *"I think the institution is ignorant about e-waste issues, no marked points for e-waste".* • *"Green information technology helps us with the ways to follow to make our environment*	• *"I learnt that when burnt it releases harmful fumes to health and pollutes the environment".* • *"Tight regulations with penalties and recycling are the*

		free from e-waste harmful effects. People when they become aware of e-waste dangers, they will then prefer GIT products than any other products".		*sustainable including our wellbeing. Electronic waste is equipment of electronic or electrical that can be harmful to the environment and health when not managed properly".*	*safest ways to ensure that e-waste has no effect to the biosphere".* • *"With regulations people will be forced to follow safe method of disposal knowing the consequences of not doing so. When you recycle you stop exploitation of resources needed to produce IT equipment"*
Source of influence	**X9**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"Communities and the environment, thanks to the digital story".* • *"Environment will be free from e-waste negative impacts and society health will benefit".*	• *"Send for recycling or donate if they will take care of the donated goods when they reach end-of-life stage".*	• *"I cannot tell because no one is talking about including our lecturers during lessons".* • *"Electronic waste is equipment that runs on electricity or of electronic that is not needed by the owner. I learnt from the story that GIT purpose is to produce, use and dispose this equipment in a way that does not harm the environment".*	• *"Electronic waste can kill and pollute the Environment".* • *"I think reducing producing more waste is the solution".* • *"When you reduce producing more you save the natural resources".* •
Source of influence	**X10**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation?	How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

				What do the phrases e-waste and GIT mean to you?	
Responses		• *"The producers of GIT products and the people".* • *"Once people are aware of e-waste impact, they will buy GIT products as a result the companies will make huge profits. Additionally, people's health will be free from e-waste health hazards".*	• *"I think give to the needy if the equipment is functional otherwise sell to e-waste collectors".*	• *"Here people are silent about it. all they talk about is cleaning the general waste such as plastics and papers".* • *"Before watching the story, I had no clue about both terms. Electronic waste is electronic or electrical device that is no longer wanted by the owner irrespective of its functioning state. Green information technology helps us with the means to manufacture and dispose this device in a way that is friendly to the environment".*	• *"Electronic waste has the potential of poisoning the crops for human consumption and drinking water once it contaminates the soil or leak into underground water sources".* • *"Reusing and refurbishing the existing IT equipment is the best solution to rescue our environment".* • *"When you reuse or refurbish you stop exploiting the natural resources. Reuse and refurbishment do not expose humans or other living things to toxins and their fumes"*
Source of influence	**X11**	**Motivation**	**Control**	**Expertise**	**Legitimation**
Questions		Who gains from GIT, and in what ways?	What should your organisation do with outdated IT equipment, regardless of how well it still functions?	What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?	How does e-waste affect the environment and human health? Which e-waste' disposal techniques do you believe to be environmentally friendly?
Responses		• *"The government and the society benefits".* • *"The government will save on medical expenditure for illnesses caused by e-waste. the society health will not be affected by e-waste and people can make extra cash by selling e-waste to the collectors".*	• *"They should give the working equipment to their best performing students if the equipment is functional otherwise send it for recycling".*	• *"No one is talking about it. therefore, GIT is not practiced in the institution. Us students we often leave computers running in the laboratories after the lectures. Even our lecturers or peer assistants do not encourage us to switch off the machines before we leave the*	• *"I think e-waste toxic fumes are deadly to the health of all living organs. Secondly it has the potential to pollute the water, soil and atmosphere".* • *"If you do not landfill, mix e-waste with general municipal waste or burning e-waste you will be doing justice to the environment. lastly stop*

			laboratories for the next lecture". • *"Electronic waste is all electrical and electronic equipment that no longer satisfy the owner's needs regardless of their working status. On the other hand, GIT is a set of strategies that are geared towards the proper management of e-waste".*	*producing more e-waste and buy only when necessary".* • *"When you don't landfill e-waste will not leak into water or soil. When you do not burn, e-waste fumes will not harm people and animals. Lastly when you stop buying carelessly you will be stopping generating e-waste"*

The participants' responses as they correspond to the four CSH sources of influence are discussed next.

8.8.2.1 Motivation

Question(s): Who gains from GIT, and in what ways?

In this case (institution), the participants' remarks expose some degree of knowing regarding the theme. The following remarks were recorded during diagnosis. Participant X7 said that "*I think is the environment*" will be advantaged. "*Organisations that uses paperless transactions. They will save money. . .*" replied X8. X9 recorded that "*user of GIT products will benefit*. *The word green is always associated with safety; therefore, they will be safe from using this product*." However, after watching the digital story, their responses were as follows: X7 said, *"I think is the environment and human health as I learnt from the story*." X8 remarked, "*manufacturers*". X9 stated, "*Communities and the environment, thanks to the digital story".* Their understanding and knowledge have been enhanced due to the digital story.

8.8.2.2 Control

Question(s): What should your organisation do with outdated IT equipment, regardless of how well it still functions?

Participant 5 can identify two effective methods to deal with the scourge of waste. The impact of the digital story is evident. X3 and 4 were not sure how it should be dealt with; however, they identified that educators (professors) are in the position to decide. Being educated does not translate to automatic sustainability awareness and most of the developing HEIs struggle with combining sustainability issues in the curriculum (Nwachukwu *et al.*, 2023:2). There is a corpus of research that advocates that GIT is a challenge at HEIs (Samoeia *et al.*, 2021:393). After exposure to the digital story, the identified participants replied in the following manner: X4 replied, *". . . sale it to the employees and students if equipment is still working. Otherwise take it for recycling*". X3 remarked, "*have a policy . . . and seek help with skilled people from outside*". Due to the digital story in building awareness, P3 and P4 are able to respond positively regarding the theme.

8.8.2.3 Expertise

Question: What steps does your company take to implement GIT? If not, what obstacles stand in the way of a successful GIT initiative's implementation? What do the phrases e-waste and GIT mean to you?

Participant X1 said, "*It is not practised . . . are no marked bins for e-waste*". X2 reported that "*Computers are left running unattended in our laboratories*"; hence is not practised. These sentiments were raised in the other cases (instances). "*They sometimes talking about climate change",* claimed X6. X11 remarked, "*No one is talking about it . . . therefore is not practiced well enough*". From the diagnostic findings, the responses point to the ineffective handling of this solid waste. On the other hand, when asked to describe GIT and the waste generated by electronic items, these were their thoughts: X4 said, "*I am not sure about both terms*." However, after the digital story, X4 remarked, "*Electronic waste is any equipment of electronic . . . not wanted"* whereas *"Green information technology . . . helps us to respect the environment".* Participant X4 is able to comment positively to this question due to the intervention. Awareness was built for participant X4.

8.8.2.4 Legitimation

Question(s): How does e-waste affect the environment and human health? Which e-waste disposal techniques do you believe to be environmentally friendly?

In the diagnostic phase, several participants (i.e., X1, X2, X5, X6 and X11) felt municipalities were more able to deal effectively with this type of solid waste. However, a body of research contradicts the participants' perspectives (Abubakar *et al*., 2022:6). X6 remarked, "*litter eventually make us ill*". This remark is very true. Negative electronic waste effects go much deeper than is perceived by the participants. In the biosphere, it contributes the carbon footprint due to emissions when burnt. It seeps into water resources when disposed of in landfills. Humans, as part of the ecosystem, got are affected due to their dependency on water (drinking), soil (food) and air (breathing).

Finding the broad conclusion from the results of an activity is the essence of **specifying learning** (Gibertonia *et al.*, 2016:377; Shu, 2022:48; Susman & Evered, 1978:588). The participants were motivated and participated in the entire research. No one decided to leave the study at any stage. However, students were reluctant to provide photographs of how e-waste is handled on the campus.The participants discovered that as information technology equipment reaches the end of its useful life, it might cause harm in addition to its benefits; thus harmful to the environment, as well as to living organisms. Participants said they should ask their student representative council and the dean's office for containers that are specifically marked for the disposal of e-waste products. Two days after watching the digital story, the researcher received the suggestion.

8.9 Similarities and differences

In all four instances, the data gathering methods were interviews after testing the digital story. The data was analysed by means of content analysis and the CSH framework. The findings in all cases were similar in that the digital story was found to create awareness. The four cases were consistent with the goal of literal replication (Perry, 2001:314). The findings from the cases were similar in that the digital story created awareness and was consistent with the literature (Maragh-Bass *et al.*, 2022:2; Snyman *et al.*, 2021:92).

8.10 Contributions relating to critical social theory

The principles of critical social theory (CST) with their corresponding codes are the following: Abstraction, totality, essence, praxis, ideology, structure, historical, and deconstruction and reconstruction (Myers & Klein, 2011:24) In the next paragraph, the researcher showed how they relate to achieving the empirical objective of the study, Critical social theory (CST) and action research (AR).

- Diagnosing phase

The purpose of the diagnostic phase was to establish SA HEIs' current levels of awareness about the problem. The important aspects of the situation were revealed during the diagnosis process within the larger framework of the problem environment and stakeholders. In this phase the HEIs in SA were found to have low levels of awareness for e-waste.

Applicable principles from CST: abstraction, totality, essence, praxis, ideology, structure, historical and deconstruction.

- Action planning

The goal of the action planning phase was to develop the intervention (digital story). The participants took ownership of developing the digital story. Following an understanding of the issue and the identification of the oppressive institutions, the CST action researcher determines acceptable and theoretically sound solutions to apply to the situation to promote emancipation. The digital story was the solution to promote emancipation. The intervention was developed through DSR principles and Kadjer’s approach (Brocke et al., 2020:2; Hevner & Chatterjee 2010:320; Kajder et al., 2005:45).

Applicable principles from CST: totality and praxis.

- Action taking

The action-taking goal was to engage participants with the digital story developed. The aim was to ensure HEIs in SA have knowledge about how hazardous e-waste could be when mismanaged. During the intervention process, the emphasis was on representatives of the marginalized.

Applicable principles from CST: praxis and reconstruction.

- Evaluation phase

The aim of the evaluation phase was to study the consequences of the action taken in the action-taking phase. This phase's objective was to assess the intervention's effectiveness.

Applicable principles from CST: totality, historical, and reconstruction.

- Specifying lessons learned

The aim of the specifying learning phase was for general findings to be identified, resulting from the previous phases of AR.

Applicable principles from CST: Abstraction.

8.11 Summary

In this section, a summary of the chapter is provided. Firstly, the effectiveness of the intervention (digital story) in creating awareness and specifying learning throughout the phases of action research for the study was evaluated.

The data for evaluation was gathered from participants who participated in the diagnostic phase. The digital story was then viewed by all the participants who gave their consent to participate in this phase. Interviews were used as a method to gather data. To view the digital story please click here.

The data was analysed through content analysis and critical systems heuristics. The findings suggested that the digital story has the potential to create awareness. The results were similar from all the cases. Furthermore, the findings supported the possibility to predict literal replication during cross-case analysis. The lesson learned was specified for each case or instance. In the next chapter, summaries from all the chapters and their contribution to the attainment of the study's main objective are provided. The contributions to the corpus of knowledge, as well as recommendations and suggestions for further research are discussed. The discussion on the contributions relating to the critical social theory was provided. The next chapter concludes the study.

CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

The aim of this study was to determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

This chapter brings the study to a conclusion with the achievement of the primary objective. The data gathering instruments for this study were semi-structured interviews, auto-photography. The themes were generated using content analysis and critical systems heuristics for evaluating the diagnosis and evaluation phases of action research. The approach of Heikkinen *et al.* (2012:8) was used to ensure rigour when evaluating the study. This framework proposed by Checkland and Holwell for doing action research in the field of information systems, from a critical social theory perspective, structured the study (Checkland & Holwell, 1998a:13; Molineux, 2018:30).

The individual contributions by each chapter to the objectives are discussed in Section 9.2. In Section 9.3, the contribution to the knowledge corpus is explored, followed by the study limitations and recommendations in Sections 9.4 and 9.5, respectively. In Section 9.6, a discussion on ethical considerations is provided. In Section 9.7, handling and reporting the results is discussed. Rigour and the evaluation method for the study is provided in Section 9.8. The discussion on areas for further research is in Section 9.9. The chapter conclusion and summary are provided in Section 9.10 and Section 9.11, respectively.

9.2 A summary of the chapters' contribution

The subsequent sections describe the contribution made by each chapter to achieve the study's objectives.

9.2.1 Chapter 1: Introduction

The reader was introduced to the main topics of research, the current problem, the pertinent components, its objectives, the research design, and ethical issues in this chapter. The objectives that were established for this study were as follows:

- **Primary objective.** To determine and create awareness of electronic waste and green information technology practices at higher education institutions in South Africa.

- **Secondary objectives.** The study's secondary goals were divided into theoretical and empirical goals.

(i) **Theoretical objectives.** To comprehend the study's key ideas, the following literature evaluations were used:

- concepts central to the study, literature that was to be reviewed and discussed to develop a sense of unity.
- research paradigms and research methodologies: these were to be explored and discussed for understanding and to motivate the chosen paradigm and methodology; and
- the chosen research paradigm and applied methodologies to be discussed to describe how it would be applied in this research.

The theoretical goals were attained as follows: A literature study on electronic waste was included in Chapter 2. Green information technology (GIT) was covered in Chapter 3, GIT. Digital storytelling and narrative were covered in Chapter 4. The rationale for the study’s paradigm, including the methodology was presented in Chapter 5.

(i) **Empirical objectives.** Critical social theory (CST) and action research (AR) phases of diagnosis, action planning, action taking, assessing, and describing the lesson were used to conduct the empirical section of this study.

- The goal of the diagnostic phase was to ascertain the present levels of participants' knowledge of e-waste and GIT practices at higher education institutions (HEIs). The outcome of diagnostic phase supported the continuance of the study.
- The action-planning phase was delegated to build the intervention (digital story).
- The action-taking goal was to engage participants with the digital story developed, using DS as a technique.
- The aim of the evaluation phase was to study the consequences of an action that happened in the action-taking phase.
- The aim of the specifying learning phase was for general findings to be identified, resulting from the previous phases of AR.

9.2.2 Chapter 2: Electronic waste

In this chapter, the definition(s), challenges and opportunities of e-waste were provided. Due to our extreme dependency on information technology, we are now unable to function in daily life without using these technologies, whether for social or commercial reasons. This leverage comes with challenges that we never anticipated; waste brought about by electronic items. Each year the volume of e-waste (functional/non-functional gadgets) is growing exponentially. By 2030, it is anticipated that there will be 74.7 million metric tonnes of electronic waste. The challenge includes health and biosphere dangers due to the mismanagement of handling this e-waste. Improper ways include informal recycling, such as open burning, landfilling, corruption by government officials and lack of infrastructure for formal recycling and lack of policy or legislation including its enforcement. However, there are benefits through transforming waste into useable substances. Their value is estimated at over United States dollars 57 billion. Problems with digital waste are especially common in underdeveloped nations due to, amongst others, the following: lack of infrastructure for recycling, poor legislation and lack of enforcement thereof. The rich regions dump their waste in the emerging regions legally and illegally, without proper support to deal with management of the waste. The life-threatening aspect of e-waste could be blamed on the lack of awareness and ignorance as suggested by the literature.

9.2.3 Chapter 3: Green information technology

Technology use that lessens the environmental effect of IT systems and infrastructure, including hardware, software, and services, is referred to as GIT. Green information technology is sometimes referred to as green computing. The goal is to decrease energy use, minimise electronic waste, and encourage environmentally friendly practices in the IT sector. Some examples of GIT practices include: (1) Virtualisation is the process of combining several physical servers into a single server or a cluster of servers using virtualisation software. This lowers the requirement for physical servers, which in turn lowers energy use and carbon emissions. (2) Hardware that uses less energy: The use of servers, storage systems, and networking tools that use less energy, such as solid-state drives (SSDs) and low-power CPUs, may considerably cut energy usage. (3) Cloud computing: By eliminating the need for on-site hardware and software, cloud computing allows businesses to access pooled computing resources and software applications through the internet, hence consuming less energy. (4) Management of electronic waste is essential to reducing the environmental effect of information technology. Reusing by recycling outdated IT equipment is an excellent approach to cut down on technological waste. (5) Working remotely, or telecommuting, lessens the need for employees to commute to work, which lowers carbon emissions and conserves energy. In general, GIT may contribute to a future that is more sustainable and is a significant component of corporate social responsibility.

9.2.4 Chapter 4: Digital storytelling

The practice of using digital tools and technology to create stories is known as digital storytelling. Digital storytelling has been praised for its capability to create awareness. In this study, the digital storytelling technique is used to create awareness in HEIs. After an extensive literature search, no studies were found that use this technique to create awareness in HIEs.

9.2.5 Chapter 5: Research methodology

The CST paradigm was utilised in conducting the investigation. Emancipating the participants justifies the usage of the CST perspective. From a CST standpoint, action research is used as the guiding approach for planning and carrying out the research. Action research is a good choice because it strives to advance theory while also serving a practical purpose. Within the Framework, Methodology and Application (FMA) framework, AR phases are organised and as needed, supplemented by appropriate methodologies. For instance, the researcher adds DSR procedures to produce an artefact during the planning stage of the AR technique used in this research (digital story). To address the issue, the digital story served as an intervention. By applying a philosophical framework of concepts to address a concern or problem in area (A) through a technique, learning can result (M). Therefore, when used as a CST practice, AR entails the application of a suitable methodology that is suitable (M) that embodies the philosophical notions of a particular framework of ideas (F) - study and address problematic background of society, i.e., an area of concern (A), to liberate stakeholders affected. The FMA illustration meant by this it is shown in Figure 9-1.

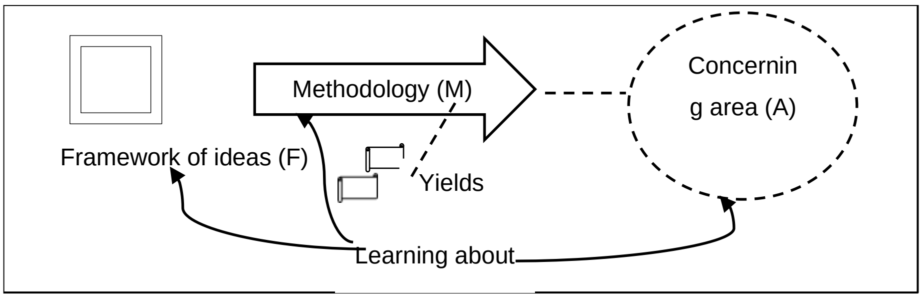


Figure 9-1: Action research process (Checkland & Holwell, 1998b)

9.2.6 Chapter 6: Diagnosing the problem

The study consists of one AR cycle from all four cases. In the diagnostic phase, the strategies, collecting data, selecting participants, and analysing data, are utilised. Interviews and auto-photography are employed to collect the data. Participants were selected purposefully. Data analysing strategies utilised were the critical heuristics systems (CSH) framework and content analysis. The chapter's goals were to define the issue and provide justification for the investigation. The findings, which indicated that HEIs have a minimal degree of awareness about the area of concern (study problem) are corroborated by the literature (Dayaday & Galleto, 2022:534). Secondly, the cross-case analysis was performed on all four cases. The results were similar from all the cases.

9.2.7 Chapter 7: Developing a solution

The digital story was developed and tested (shown) in one of the cases before the evaluation and specifying learning phases. The digital story was developed using the DSR and Kadjer's approach in developing the digital story. The digital story was developed and shown to case 1 participants (university of technology) before being rolled out to all the cases. To view the digital story please click here.

9.2.8 Chapter 8: Testing the digital story

The chapter was all about testing the digital story and specifying the lesson learned. The aim to test the digital story was to evaluate the outcome of the digital story. Data for evaluation was gathered from participants who watched the digital story. Interviews were used as data gathering method. The gathered data was analysed with content analysis and critical systems heuristics framework. The findings of the evaluation phase showed that a digital story can create awareness. The findings are in keeping with literary sources (Park *et al.*, 2021:16). Secondly, the cross-case analysis was performed on all four cases. The results were similar from all the cases. The contributions of the study how they relate to CST were discussed.

9.3 Study contribution to knowledge

Theoretical contributions: The research increased the very little that is known in HEIs about studies that are conducted from the CST perspective. The study has orientated the reader about CST as a paradigm and its use in awareness creation and emancipation in HEIs.

Empirical contributions: The empirical significance of this research is that it provided insight into processes of awareness creation under the model of FMA by Checkland and Holwell (1998a:13). Very little research has been done on CST's role in creating knowledge and understanding about the study problem and solution approaches at HEIs. The researcher applied CSH's and content analysis to evaluate the intervention and to reflect on specifying learning. Other aspects that this study revealed are the emerging patterns, such as institutional management of waste produced by electronic products, disposal strategies on waste caused by electronic items, the environment and well-being thereof, GIT advantages and beneficiaries, and difficulties implementing GIT, curriculum, awareness and GIT initiatives and its relation to awareness creation in HEIs. Another contribution is that the study offers an alternative method to address sustainability issues that concern the biosphere.

9.4 Limitations of the study

The researcher identified a few study weaknesses that may be addressed in further studies. The researcher acknowledges the limitation of personal bias. Personal bias may have had an impact on either the creation of the interview guide/research questions or in the interpretation of participants' responses. While the researcher endeavoured to prepare for this predisposition, it might in any case have fallen through somewhat because of the subjectivity of the research design (qualitative design). The study investigator aimed to gather data using interviews, auto-photography, and official documents. Not all cases participated on taking photographs and official documents were not available from all cases during the time of data gathering. Participants were not willing to take photographs. The study was limited to specific HEIs public Technical and Vocational Education and Training (TVET) colleges, a public University of Technology (UoT) and a public university and their specific participants (students and ITTs). The study focused on HEIs in two provinces (Gauteng and Free State). Therefore, findings may vary in other locations. This study with a larger sample sizes and participants from other public or private HEIs may reveal additional data and further outcomes. The study is qualitative in nature. Therefore, the emphasis was not on generalisability. Despite these limitations, the research's findings help to clarify how CST is used to carry out awareness-creating activities utilising DS in HEIs.

9.5 Recommendations for the study

The research's conclusions might be used as a reference for other researchers who are conducting research pertaining to e-waste awareness at HEIs. Taking direction from the emerged patterns the recommendations are proposed below.

- **Pro-environmental curriculum**

The study suggests that the HEIs' curricula should include lessons on GIT and e-waste. Higher education institutions must raise awareness of GIT in order to influence/educate, direct, and execute GIT practices (Salvioni, Franzoni & Cassano, 2017:1). From content analysis and the CSH framework in this study, a list of good practices could be proposed, for example, carrying out sustainability in HEIs by adding environmental subjects in undergraduate courses; engaging the institutional community (students, staff and researchers) in e-waste management activities (Vargas & Campos, 2020:84).

- **Increase stakeholder’s involvement**

Lack of stakeholder involvement was found to contribute to the implementation challenges of GIT practices. It is difficult to manage electronic waste, hence it requires the involvement of all stakeholders (Saldaña & Messina, 2021:8). According to Badu-Yeboah, Amoako and Adarkwa (2018:431), a lack of stakeholder involvement in decision making is the driver of poor e-waste management in organisations. Therefore, it is critical to teach all stakeholders (e.g., staff, students, top management and academics) of HEIs to think of GIT for a sustainable environment. Green information technology helps HEIs to acknowledge social benefits, such as improved institutional image, reputation, and trustworthiness among all stakeholders.

- **Lack of an e-waste disposal plan**

Challenges for implementing an e-waste disposal plan from this study are associated with a lack of funding, unwillingness, lack of awareness, limited capacity of public HEIs and inadequate infrastructure. They are all supported by the literature (Badu-Yeboah *et al.*, 2018:431). In conclusion, a formal disposal plan should be instituted, followed up and communicated to stakeholders.

- **Electronic waste awareness**

The primary task for HEIs is to create awareness amongst all HEIs stakeholders about effective disposal of waste generated by electronics. Purwaningsih (2018:20402) suggested that the benefits of GIT practices in HEIs are realised by creating e-waste management strategy implementation in both academic and non-academic activities. Primarily HEIs should use their potential benefit for the scholarly community to engage itself and bring about improvement through education, research, and outreach. The starting point should be institutional awareness programmes (i.e., the use of posters and flyers). It would be paramount to hire professional(s) to work specifically on sustainability issues related to waste from electronic equipment.

- **Internal stakeholders**

Internal stakeholder training (staff, academics and managers) is essential for GIT support and its implementation. Stakeholders need to be trained and skilled appropriately on environmental GIT practices' advantages against e-waste effects.

9.6 Ethical considerations

The subsequent discussions explained how the ethical issues identified and discussed in Section 1.6 were dealt with in this study. Due to the fact that this study involved human volunteers, ethics was a crucial factor in its effectiveness (Makhoul, Chehab, Shaito & Sibai, 2018:2). Additionally, it worth noting that the researcher had attended ethics training (ANNEXURE B).

9.6.1 Autonomy and beneficence

The researcher ensured that the informed consent was documented and offered it in writing for convenience. The name of the participant, date, study title, and participant's signature were all included on the document. The researcher's commitment was guaranteeing the participants were informed and joined the study wilfully instead of being pressured. The researcher held that the fundamental and guiding ethical guideline guiding the conduct of qualitative research is informed consent. According to the concept of autonomy, participants must get enough information to make an informed decision about participating in the study or not (Cosac, 2017:20; Yang & Munir, 2004:40). All participants' rights, autonomy, and dignity were upheld. Before data gathering, the participants gave written consent to participate. The primary definition of beneficence is to do no harm, to maximise potential benefits and minimise potential downsides (Tajir, 2018:5; Yip, Han & Sng, 2016:685). The study did not expose the participants to any form of harm or danger. There were no vulnerable participants, such as children, or participants in dependent relationships with the researcher. The research design of this study did not pose any harm to the participants (physical, emotional, or psychological). There was no misuse of the research findings in anyway. The study benefited the participants with awareness on the study's issue.

9.6.2 Confidentiality and anonymity

While gathering, analysing, and reporting data, confidentiality and anonymity and ethical practices are intended to protect the privacy of participants. Alias names were established for each participant to maintain their anonymity and confidentiality. Participants data was coded so that participants could not be identified. No participants were excluded from the study by reasons of language, gender, ethnicity, or culture, for example. The researcher never used deception in this study (Sobočan, Bertotti & Strom-Gottfried, 2019:807). The participants were allowed to check their own raw data after seeking permission from the researcher. Confidentiality of the interview environment was managed carefully throughout the process of the investigation. The researcher conducted the interviews in a setting that was convenient and friendly for the participants. The safeguarding of sensitive data was ensured in large part through upholding confidentiality. Participants' personal information was saved on cloud with a password. Information on participants was stored by the researcher in a secured locked cabinet. Five years will pass before the material is deleted. Prior to the event, the decision to retain their data was discussed and approved by the participants. After receiving a certificate of ethics clearance (ANNEXURE A), the process of collecting research data was completed. To guarantee that the study was carried out in an ethically sound manner, the certificate was issued or created to protect the NWU, the researcher, the participants, and the environment.

9.7 Data handling and reporting

It is morally required to inform the participants of the study's results (Curran, Kekewich & Foreman, 2018:1; Fernandez, Kodish & Weijer, 2003:12). There was no injury or distress caused to the subjects in disclosing the study's findings. Only participants who requested data were allowed to share it.

9.8 Method of evaluation and rigour

(Heikkinen *et al.*, 2012:9) stated that the following five concepts should guide us throughout the whole process of AR validation. The concepts are discussed next.

9.8.1 Principle of historical continuity

The need for understanding the socio-historical context of every AR endeavour is emphasised. The purpose of this study was to analyse the possibility for research to empower people. The researcher discussed the use of the AR stages, described the intervention strategy, and evaluated the effectiveness of AR intervention by describing what the investigator had discovered in terms of the FMA framework's components.

9.8.2 Principle of reflexivity

While participating in this study with others, the researcher was aware of personal experiences influences, and the research materials and procedures were described in the research report. Reflexivity is describing the research process in as much detail and honesty as possible, explaining the researcher's stance in connection to the research (Reay, 2007:611). The researcher used content analysis and CSH's source of influence to analyse the data from the diagnostic phase (Bengtsson, 2016:9; Reynolds, 2007:101). To get a thorough understanding of the data during the assessment phase, the researcher combined content analysis with CSH evaluation.

9.8.3 Principle of dialectics

The investigator respected the participants' varied viewpoints and attempted to accurately reflect them in the report. To confirm, gather, and evaluate the data gathered for this study, the researcher used the following procedure: The researcher first conducted one-on-one interviews with each participant. Secondly, personal visits to each participant corroborated the interview results (Long & Johnson, 2000:33). As recommended by Long and Johnson, the member check's goal was to satisfy the conditions of diachronic dependability (stability over time) (Long & Johnson, 2000:33). Thirdly, following Jamshed's advice, the researcher examined the participant replies verbatim and thought about the knowledge gained from the information (Jamshed, 2014:87). The researcher presented the data at international conferences and spoke with informed colleagues about the new discoveries (Robinson, 1993:404).

9.8.4 Principle of workability and ethics

A study should lead to ethical and important improvements in social behaviour. The goal of this study was to create awareness of HEIs' use of GIT and e-waste. A professional was consulted to provide feedback on the digital story to determine whether it would be effective in creating awareness. Since participants in the study were humans, it was important to take ethical concerns into account both before and after the study. The concerns of privacy and anonymity were taken into account while making the results public (Sim & Waterfield, 2019:3008). Other concerns were the avoidance of potential damage at the time of publication.

9.8.5 Principle of evocativeness

In the research report, the researcher evaluated the study in terms of FMA. The reader of the study is involved on an emotional level in addition to his/her cognitive and logical reasoning (Heikkinen *et al.*, 2012:10). The study was described and published to serve as a reminder to the reader that the majority of ICT equipment is manufactured from finite natural resources (Ohajinwa *et al.*, 2017:1). These resources must be preserved for future generations or there will be a shortage (Kahhat, Hieronymi & Williams, 2012:3).

9.9 Further research areas

It would be useful if future research could examine what efforts HEIs have taken to improve e-waste and GIT practices' awareness among their internal stakeholders. Future studies should concentrate on how developing nations, particularly those in sub-Saharan Africa, could adopt the successful e-waste management practices seen at HEIs in wealthy nations. According Mbewe

(2019:146), awareness in emerging economies is low. Considering the limited scope for investigation, it is suggested that a more in-depth study ought to be done to give more insights into related areas of the pro-environmental issues at HEIs utilising CST as a new approach. Such a study may work on the off chance that it incorporates action to implement the CST approach adequacy with the target of building up what works and what will not work in different settings. For generalisability another quantitative study can be conducted.

9.10 Conclusion

The study had four cases within one AR cycle. During the diagnostic phase, the issue of low knowledge of e-waste and GIT practices was discovered in each case. The digital story was tested using those who took part in the diagnostic phase. The study further compared all the cases for similarities and differences. The results in the diagnostic and evaluation phases from all the cases were similar. In the evaluation phase, the level of awareness of the participants from all the cases was raised after watching the digital story. The findings of the evaluation phase revealed that the digital story could create awareness. The discussion on how the findings or contributions of the study relate to the CSH were provided.

9.11 Summary

A brief exposition of how each chapter contributed to the achievement of the study goal, that is, to create awareness of electronic waste and green information technology practices at higher education institutions through digital storytelling is provided. In Chapter 1, the reader was engaged and the context for the research on a pertinent topic with a distinct emphasis, goal, and direction was established. In Chapters 2, 3 and 4 the discussions on the literature of the concepts central to the study were summarised. In Chapter 5, the study’s research methodology was presented and in Chapter 6, diagnosis of the problem and justification for the continuation of the study were outlined. In Chapter 7, there was a summary of the development of the intervention and in Chapter 8, both the evaluation and specifying learning phases of action research for the study were addressed.

The contribution of the study to the corpus of knowledge was followed by the limitations of the study. The handling of the ethical issues, rigour and the evaluation of the method throughout the study were also discussed. Finally, the recommendations for future research were suggested.

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ANNEXURE A: ETHICAL CLEARANCE CERTIFICATE

NWU®
NORTH-WEST UNIVERSITY
NOORDWES-UNIVERSITEIT
YUNIBESITI YA BOKONE-BOPHIRIMA

Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: http://www.nwu.ac.za

Senate Committee for Research Ethics
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) 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.

Study title: Creating awareness of electronic waste and green information technology practices at higher education institutions through digital storytelling
Study Leader/Supervisor: Dr I Smit
Student: RI Moletsane

Ethics number: N W U - 0 1 1 7 6 - 1 9 - A 9

Institution | Study Number | Year | Status

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application type: Single **Risk Category:** Minimal

Commencement date: 01/02/2019
Expiry date: 28/02/2024

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
  - Research proposal
  - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

File reference: 9.1.5.4.2 Page 1 of 2

ANNEXURE B: ETHICS TRAINING CERTIFICATE

Vaal University of Technology

Your world to a better future

VUT

Research Directorate
Tel: +27(0)16 950 9000
Fax: +27(0)16 950 9898

Dear Mr Ramadile Moletsane,

ATTENDANCE AT RESEARCH ETHICS TRAINING WORKSHOP

The letter confirms that you attended the Research Ethics Training Workshop offered on behalf of the Vaal University of Technology (VUT), Research Directorate, and presented by Prof T Padayachee and Prof A Munro, on the 12 &13 September 2019. The programme presented is attached.

Having accomplished this, you are entitled to be appointed to serve on your Faculty Research Ethics Committee.

We encourage you to keep this letter and the accompanying document as part of your portfolio of accomplishments.

Congratulations!

Sincerely

Dr S Nelana (Director: Research Directorate)

Prof T Padayachee

Prof A Munro

(Course presenters)

1

Vanderbijlpark Campus - Private Bag X021 - Vanderbijlpark - 1911 - Andries Potgieter Blvd
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ANNEXURE C: CONSENT LETTER

Informed Consent Letter

Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects because of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you have questions regarding your rights as a research participant, or if problems arise that you do not feel you can discuss with the Primary Investigator, please contact the NWU Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) at **(**018) 299-4849**.**

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

CONSENT

I have read, and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature ______________________________ Date __________

Investigator's signature _____________________________ Date __________

Participant's Initials: ________

ANNEXURE D: DATA GATHERING TOOLS

DATA COLLECTION TOOL 1 (interview guide)

- What do the phrases "*e-waste*" and "*GIT*" mean to you?
- How does "*e-waste*" affect the environment and human health?
- Which "*e-waste*" disposal techniques do you believe to be environmentally friendly?
- Who gains from "*GIT*", and in what ways?
- What should your organisation do with outdated "*IT equipment*", regardless of how well it still functions?
- What steps does your company take to implement "*GIT*"? If not, what obstacles stand in the way of a successful "*GIT*" initiative's implementation?

DATA COLLECTION TOOL 2 (auto-photography method)

These are sample photographs taken by the participants during the diagnosing phase.

(a) Cables, Mice, computer boxes

(b) Printer, cables, monitors

(c) Cables, monitor, computer boxes

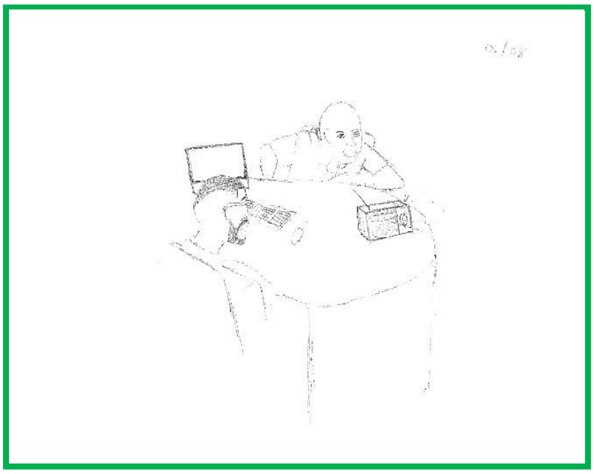
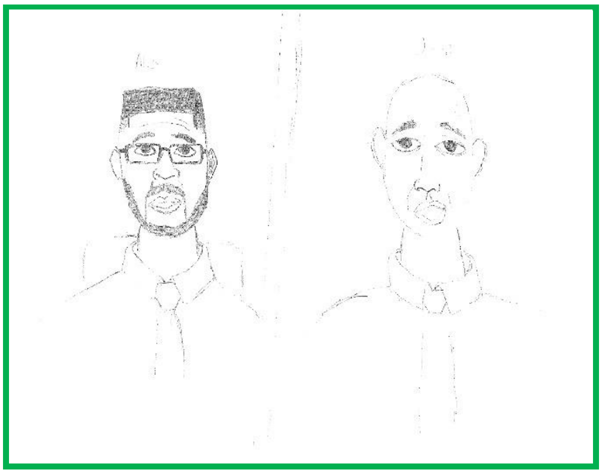
(d) Computer monitors

ANNEXURE E: STORYBOARD PLANNING PICTURES

These are some of the storyboard planning hand drawn pictures.



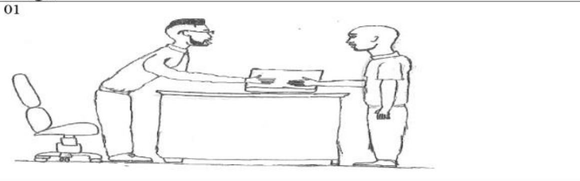
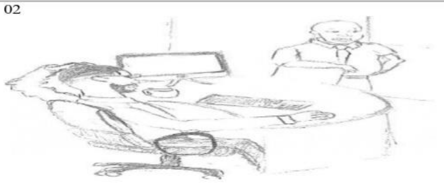


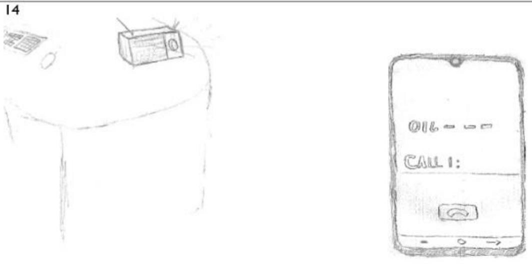
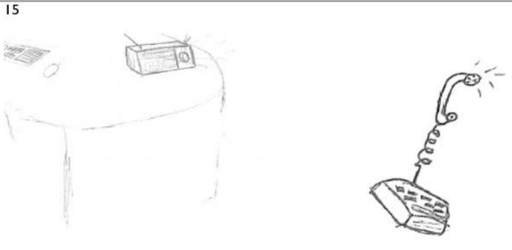



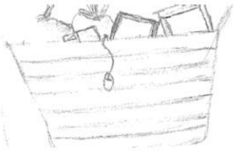
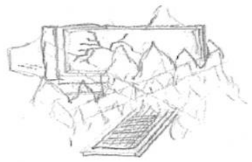
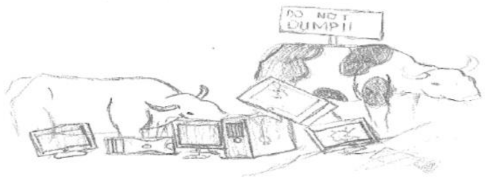
ANNEXURE F: STORYBOARD AND SCRIPT

These are storyboarding and script extracts:

Storyboard and script
Music: Romantic
Song: Brothers Unite by: Alexander Nakarada
Source: Internet (https://freepd.com/romantic.php)

Images	Description/Dialogue
01 	John: "Hello Alex." Alex: "Hi buddy."
02 	**John**: "I have been thinking of what we should do about…" **Alex**: "About what?"

14 	**Caller 1: "**Hello Mr B. My name is Sam. Why can't e-waste be stopped or eliminated?" **Radio presenter: "**Sam, e-waste cannot be eliminated. It can only be managed in ways that are not harmful to the environment."
15 	**Caller 2:** "Hi Mr B, my name is Sue. What prevents people from managing e-waste in a manner friendly to the environment?" **Radio presenter**: "Sue that was a great question. People are unaware of the consequences of not disposing of e-waste in a manner friendly to the environment."

<table>
<tr>
<td>18



</td>
<td>Radio presenter: “Do not mix e-waste with general municipal waste, as municipality waste end up in landfills.”
Radio presenter: “Do not burn e-waste as it releases toxic fumes.”
Radio presenter: “Do not dump, e-waste bio-accumulates, meaning it keep accumulating in the bodies of the living things posing harm to health, life and the environment.”</td>
</tr>
<tr>
<td>20</td>
<td>Alex: “Dude don’t worry. This programme is to make us aware about dealing with e-waste disposal.”</td>
</tr>
</table>

ANNEXURE G: DECLARATION BY THE LANGUAGE EDITOR

This serves to confirm that I, Isabella Johanna Swart, registered with and accredited as professional translator by the South African Translators' Institute, registration number 1001128, language edited the following thesis (excluding the verbatim transcription of the interviews):

Creating awareness of electronic waste and green information technology practices at higher education institutions through digital storytelling

by

RI Moletsane

Dr Isabel J Swart

Date: 7 October 2023

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ANNEXURE H: DECLARATION BY THE TECHNICAL EDITOR

Funky Formatters
Document Formating Service
Petra Grainsford 082 924 5081 petra.gainsford@nwu.ac.za

I, Petra Gainsford (ID number: 6903090040089), hereby declare, that I have done the technical editing for RI Moletsane, for Thesis submitted for the degree Doctor of Philosophy in Computer and Information Sciences with Information Technology at the North-West University.

Petra Gainsford