# Challenges in transitioning to Green ICT in a South African telecommunication company

**by**
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**SUPERVISOR: Prof B Sookdeo**

**Date: 11 November 2025**

**DECLARATION**

Name: Sivapragasen Naidoo .

Student number: 40510859 .

Degree: Master of Commerce in Business Management .

Exact wording of the title of the dissertation as appearing on the electronic copy submitted for examination:

**Challenges in transitioning to Green ICT in a South African telecommunication company**

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.

*(The dissertation will not be examined unless this statement has been submitted.)*

11 November 2025

SIGNATURE DATE

## ACKNOWLEDGEMENT

First and foremost, I thank God Almighty for granting me the strength, wisdom and perseverance to undertake and complete this research.

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I am especially grateful to my wife, Samantha Naidoo, for her unwavering love, patience and encouragement. To my parents, Sivaramakrishnan Naidoo and Pushpum Naidoo, your sacrifices, values and constant support have been the foundation of my journey and growth. To my beloved children, Kaylin, Tyana and Nalyssa, your love, inspiration and understanding gave me the strength to persevere and the motivation to complete this work.

Finally, I thank my friends and colleagues who offered words of encouragement, inspiration and belief in my ability to complete this study.

## DEDICATION

This dissertation is dedicated to my wife, Samantha Naidoo; my parents, Sivaramakrisha Naidoo and Pushpum Naidoo and my children, Kaylin, Tyana and Nalyssa, in appreciation of their unwavering support.

## ABSTRACT

Green Information and Communication Technology (Green ICT) adoption has become a global priority due to the rising environmental impact of ICT operations. Literature indicates that although awareness of Green ICT principles is steadily increasing globally, their actual implementation within organisations remains limited; with the gap especially visible in developing economies. This study focused on a leading telecommunications organisation in South Africa which faces challenges in aligning sustainability within ICT operations. The primary objective of the study was to identify the challenges facing a South African telecommunications organisation in transitioning to Green ICT. The underpinning theory of the study included the Green IT Adoption Model (GITAM), which guided the study, and the Technology, Organisation and Environment (TOE) framework's categorised findings across technological, organisational and environmental dimensions. A quantitative research design was applied, using a self-administered questionnaire distributed to technology employees via simple random sampling; with data analysed using descriptive statistics and one-sample t-tests. The main finding indicated a clear gap between awareness and practical implementation. The main conclusions highlighted that organisational readiness, strategic alignment and environmental pressures significantly influence adoption; while financial constraints, limited training and poor communication hinder progress. The management implications of the study included the need for stronger leadership support, improved training frameworks, enhanced communication strategies and better resource allocation to accelerate adoption. The main recommendations were the necessity for targeted investment, comprehensive awareness initiatives and collaborative engagement with stakeholders. The study contributes academically by addressing gaps in Green ICT literature and practically by providing actionable insights for the organisation under study and the wider telecommunications sector. Given its strategic role in reducing carbon emissions, improving energy efficiency and promoting sustainable practices, further studies regarding Green ICT adoption are suggested for the South African telecommunications sector.



**Keywords:** Green ICT, sustainability, GITAM, TOE framework, telecommunications

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| 4G | Fourth-Generation Wireless |
| 5G | 5th Generation Mobile Networks |
| AI | Artificial Intelligence |
| BS | Base Station |
| CDNs | Content Delivery Networks |
| CE | Circular Economy |
| $CO_2$ | Carbon dioxide |
| COP | Conference of the Parties |
| CSV | Corporate Shared Value |
| DOI | Diffusion of Innovations |
| DRC | Democratic Republic of Congo |
| FTTH | Fibre to the Home |
| FTTx | Fibre To The x |
| FY | Financial Year |
| G-readiness | Green readiness |
| GDP | Gross Domestic Product |
| GHG | Green House Gases |
| GICT | Green Information and Communication Technology |
| GIoT | Green Internet of Things |
| GIT | Green Information Technology |
| GITAM | Green Information Technology Adoption Model |
| Green ICT | Green Information and Communication Technology |
| Green IT | Green Information Technology |
| ICT | Information and Communication Technology |
| IoT | Internet of Things |
| IS | Information System |
| IT | Information Technology |
| IT | Information Technology |
| KPI | Key Performance Indicator |
| LEO | Low-Earth-Orbit |
| LIC | Liquid Immersion Cooling |

| | |
|---|---|
| ML | Machine Learning |
| NB-IoT | Narrowband Internet of Things |
| NGPoPs | Next-Generation Points of Presence |
| REC | Renewable Energy Certificate |
| SDG | Sustainable Development Goal |
| SDGs | Sustainable Development Goals |
| SSA | Sub-Saharan African |
| TAM | Technology Acceptance Model |
| TOE | Technology-Organisation-Environment |
| TPB | Theory of Planned Behaviour |
| TRA | Theory of Reasoned Action |
| UAVs | Unmanned aerial vehicles |
| UN | United Nations |
| USEPA | United States Environmental Protection Agency |
| UTAUT | Unified Theory of Acceptance and Use of Technology |
| VM | Virtual Machine |

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# CHAPTER 1: INTRODUCTION TO THE STUDY

## 1.1 INTRODUCTION

This chapter presents a cohesive and integrated blueprint structure of this study. Moreover, this chapter provides an overall view of the background of the study, problem statement, research questions, research aim, research objectives, research statement, research methodology, validity and reliability, ethical considerations and the significance of the study. The chapter outline is shown in Figure 1.

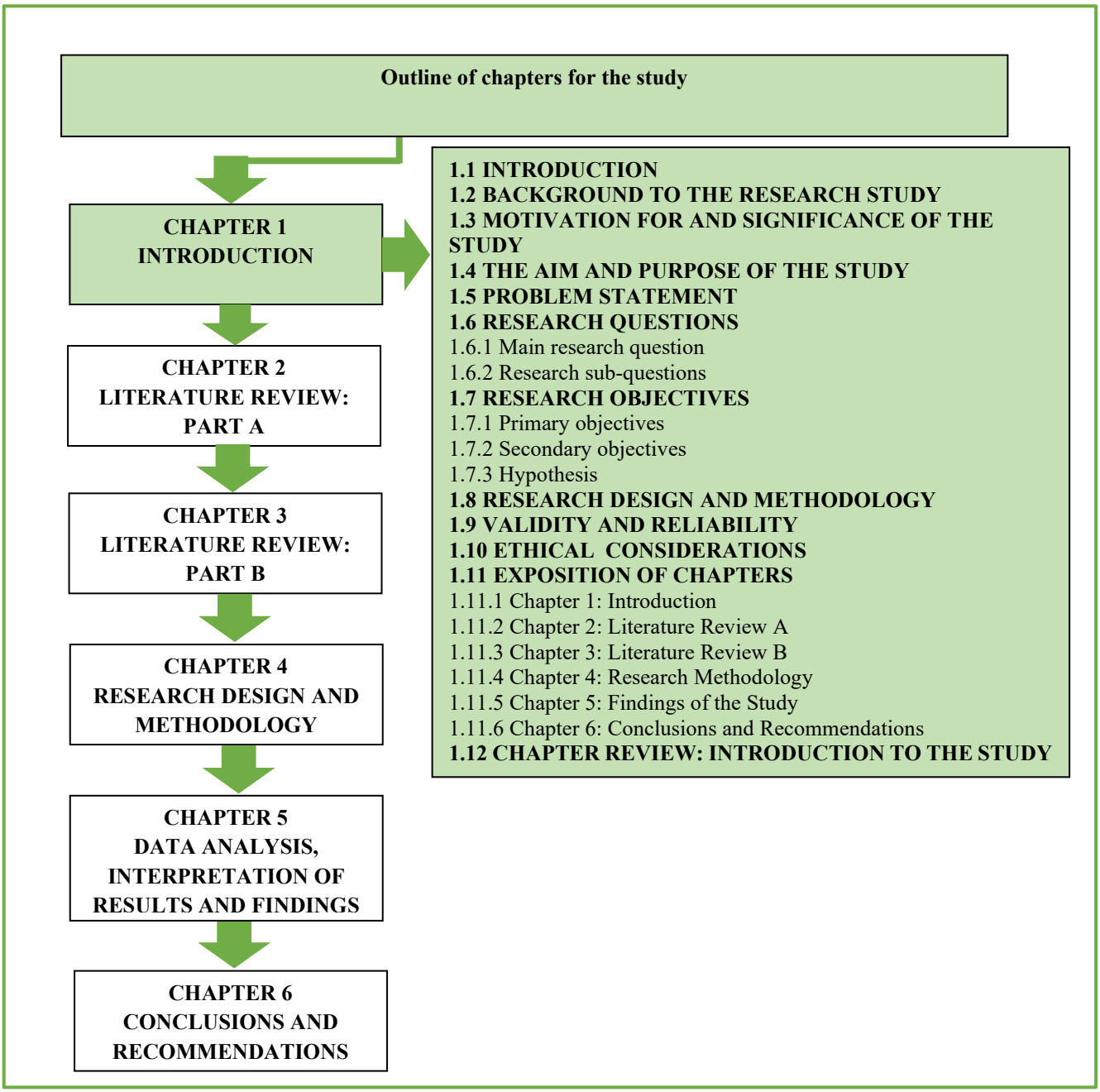


**Figure 1.1**: Outline of Chapter 1
**Source:** Author's compilation (2025)

Transitioning to renewable and clean energy sources, supporting eco-friendly progressions (green innovation) and promoting a "green" mindset exhibits a nation's commitment to preserving its natural environment, conserving resources and ensuring the well-being of its citizens (Ramzan, Abbasi, Salman, Dagar, Alvarado & Kagzi, 2023). To reduce greenhouse gas emissions and its adverse environmental impacts, the telecommunications sector needs to rapidly transition to environmentally friendly Information and Communication Technology (ICT) practices because of its rapid growth. Verdecchia, Ricchiuti, Hankel, Lago and Procaccianti (2017) assert that Green ICT is a set of actions that intends to reduce the adverse effects of ICT on the environment while taking advantage of the positive impact it can provide. The Green IT (Information Technology) concept originated in 1992 with the United States Environmental Protection Agency's Energy Star program. This voluntary labelling system is intended to identify and promote energy-efficient computers, monitors and equipment; assisting organisations in saving money and reducing greenhouse gas (GHG) emissions (Klopper & Meyer, 2020).

The telecommunications sector, while experiencing transformations through the phases of industrialisation and information, has welcomed a variety of actions that strengthen technological advancement and enrich services throughout countries globally (Khater, 2021). The rapid growth of the telecommunications sector, fuelled by a technological revolution and the higher demand for user data, presents challenges for network operators in achieving their energy needs. This is due to limited fuel resources and growing concerns regarding global warming as more base stations are deployed globally to meet the demands of rising mobile subscribers (Hossain, Jahid, Islam & Rahman, 2020). ICT is essentially comprised of software, hardware, networks and media; extensively utilised for gathering, interpreting, processing, storing and transmitting information in various formats such as voice, data, text and images, while also offering numerous other services, all under its two principal components: information and communication infrastructure (Al-Rahmi, Alzahrani, Yahaya, Alalwan & Kamin, 2020).

While ICT evolutions have contributed to economic growth, daily life convenience and reduced environmental impacts, concerns arise from the sector's increasing energy consumption and

GHG emissions (Zhang, Shinozuka, Tanaka, Kanamori & Masui, 2022). ICTs stimulate sustainable development, play a vital role in realising Sustainable Development Goals (SDGs) and have been vital in moving towards a low-carbon economy since the 2000s, with the Green ICT initiative concentrating on reducing their adverse environmental effects (N'dri, Islam & Kakinaka, 2021). The telecommunications sector holds a key position and is crucial to the ICT industry. Telecommunications services, which are fundamental for socio-economic growth, are seeing a rapidly increasing user base with further anticipated growth, leading to a corresponding increase in the number of critical telecommunications towers (Deevela, Kandpal & Singh, 2023).

South African telecommunications organisations are investing primarily in fibre and 5th generation mobile networks (5G) (GlobeNewswire, 2022). ICTs, especially mobile technologies, have been acknowledged as the main contributors to economic and social improvement (Gillwald, Mothobi & Rademan, 2018). The need for Green ICT is more pertinent now than ever and Africa should not be left behind (Addo, Akabua, & Akpatsa, 2019). The adoption of Green IT is crucial in organisations as it promotes innovative methods to lessen atmospheric pollution, introduces more efficient and alternative energy generation systems, explores diverse data servers, promotes the production of recyclable computers and promotes the usage of less hazardous materials in technological evolution (Klopper & Meyer, 2020).

Acknowledging the challenges and opportunities presented by climate change, the telecommunications company under study integrates these considerations into their strategic planning to maximise stakeholder value and proactively monitors global trends to take advantage of opportunities emerging from the transition to a low-carbon economy (TFCD Report, 2023). For the purpose of this study, this telecommunications company will be referred to as "Organisation A" throughout the study. The risks are significant if Organisation A fails to successfully transition to a more sustainable business model in the given timeframe; particularly in light of South Africa's move to a low-carbon economy through the phasing out of fossil fuels, adoption of renewable energy technologies and commitment to reducing greenhouse gas emissions, as highlighted by corporate adherence to the Paris Agreement and net-zero targets (TFCD Report, 2023). Based on the given information, it's clear that the telecommunications sector should swiftly incorporate Green ICT practices into their operations.

This study aims to identify the primary challenges of transitioning to Green ICT in a telecommunication company in SA and to determine the factors that would support Green ICT implementation in the telecommunications sector. In this research study, a quantitative method was employed, involving a non-experimental, descriptive approach, with survey questionnaires serving as the principal instrument for data collection. Figure 1.2 presents an overview of the study.

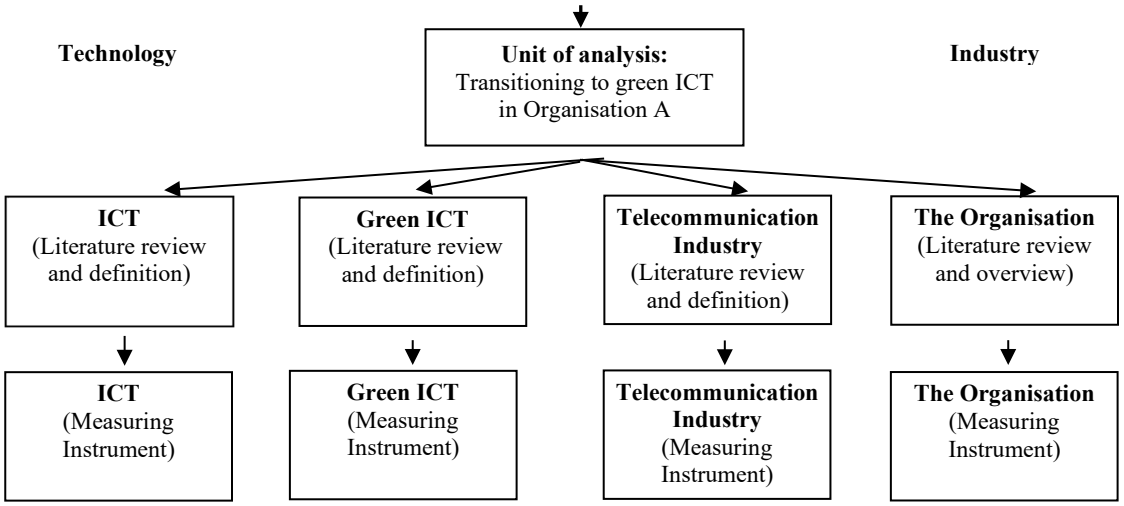
**Problem Statement (Summarised):**

Organisation A, a telecommunications company in South Africa, faces challenges in transitioning to Green ICT. This transition is crucial in light of global environmental concerns and the need to reduce greenhouse gas emissions. Failure to transition poses risks to Organisation A. On the other hand, successfully transitioning to Green ICT offers opportunities for market capture, improved sustainability performance, enhanced consumer attractiveness and cost reduction. Overall, the transition to Green ICT is essential for both addressing environmental concerns and ensuring the long-term success of Organisation A.

↓

**Research objective:**

This study focuses on identifying the primary barriers and challenges faced by a South African telecommunication organisation in transitioning to Green ICT. It aims to understand the factors that can facilitate the implementation of Green ICT and assess the impact of these barriers on the transition process. Additionally, the study seeks to propose effective strategies and a comprehensive framework to overcome these challenges and promote sustainable practices within the organisation. By addressing these objectives, the research aims to contribute to the successful adoption of Green ICT in the telecommunications industry in South Africa.




**Research Design:**
Cross-sectional quantitative surveys

↓

**Sector:**
Telecommunication

↓

**Target population:**
Technology employees

↓

**Hypothesis:**

**Hypothesis H1:** The current state of Green ICT adoption in Organisation A is suboptimal.

**Hypothesis H2:** There are significant challenges and barriers impacting Organisation A's transition to Green ICT.

**Hypothesis H3**: A higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A.

↓

**Data Analysis:**
Descriptive research

↓

**Findings:**
Results of the study

**Figure 1.2:** Overview of the study
**Source:** Author's own compilation (2024)

## 1.2 BACKGROUND TO THE RESEARCH STUDY

The rapid growth of ICT over the past 70 years has raised questions about its impact on climate change through the release of greenhouse gases during its life cycle, including manufacturing, operation and disposal (Freitag, Berners-Lee, Widdicks, Knowles, Blair & Friday, 2021). Addressing global warming and environmental challenges has become a central concern across industries, driven by regulatory requirements and market pressures to promote a sustainable and eco-friendly world (Islam, Muthaiyah & Fie, 2020). At present, the production and utilisation of ICT account for 2% of the world's carbon dioxide emissions (Atsu, Adams & Adjei, 2021). ICT can both mitigate negative environmental effects from sectors outside its own that contribute to the environmental footprint and, through Green ICT practices, decrease its own direct environmental impact (Hankel, Heimeriks & Lago, 2019). South Africa (SA) and many sub-Saharan African (SSA) countries have substantially grown their telecommunications infrastructure; therefore, a need exists to recognise the best way to implement them to reduce negative emissions into the environment (Atsu et al., 2021).

Green ICT strives to reduce the negative effects of ICT on the environment and climate change by cutting down on energy usage and carbon dioxide emissions related to ICT (Zafar, Zaidi, Mansoor, Sinha & Qin, 2022). By transitioning to renewable and clean energy sources, embracing eco-friendly innovations (referred to as green innovations) and fostering a "green" mindset, a country showcases its commitment to protecting the natural environment, preserving resources and promoting the well-being of its people (Ramzan et al., 2023). Many industries rely on the telecommunications sector for their regular operations (Tamuka & Sibanda, 2020). Over the past few decades, the intersection of ICT, climate change and energy transition has gained significance for human well-being; with sub-Saharan Africa, especially SA, paying close attention to climate change's negative economic effects (Atsu et al., 2021).

Organisation A serves as an enabler, with the aim of supporting governments, communities, enterprises and individuals by implementing its strategy in a way that promotes the achievement of the SDGs (Sustainability Report, 2022). Organisation A holds the belief that business success should not be at the cost of the environment and they are dedicated to minimising the environmental impact of their operations (Sustainability Report, 2022).

Organisation A recognises the physical and transitional risks, as well as possible financial consequences of climate change, and identifies opportunities emerging from the shifting business environment in a net-zero world, such as new market and investment prospects, while aspiring to advance the SDGs through its adoption of the Circular Economy (CE) (TFCD Report, 2023). A CE is a strategic and sustainable economic model that aims to improve resource use, minimise waste, prolong product value, lessen primary resource dependency and operate within closed-loop cycles, all within the scope of environmental safety and socio-economic enrichment (Morseletto, 2020).

Figure 1.3 below shows a breakdown of the greenhouse gas emissions generated through Organisation A's operations in several African nations.

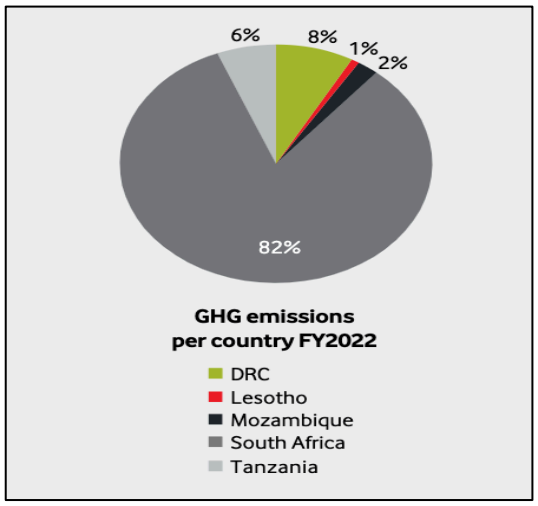



**Figure 1.3**: Greenhouse gas emissions per country

**Source**: Sustainability Report (2022)

Additionally, SA hosts a considerable portion of Organisation A's group's operations, which, as Figure 2 demonstrates, accounts for 82.3% of the group's total greenhouse gas emissions (Sustainability Report, 2022). Significantly, the main sources of carbon emissions for Organisation A stem from electricity usage across different areas: access (84%), technology centres (13%) and buildings (3%) (Integrated Report, 2023). The lack of transition to a green society could render Organisation A vulnerable to diverse climate-related risks such as escalating energy consumption, dependency on external parties, unstable costs pertaining to carbon offset schemes, potential damage to reputation, modifications in regulatory requirements, evolving consumer preferences and a heightened likelihood of litigation related to climate action (TFCD, 2023). Consequently, this research study aims to identify the primary

challenges when transitioning to Green ICT in a telecommunication organisation in SA and to determine the factors that would support Green ICT implementation in Organisation A.

## 1.3 MOTIVATION FOR AND SIGNIFICANCE OF THE STUDY

This study in Organisation A was motivated by the challenges faced in transitioning to Green ICT, particularly in the telecommunications sector, in response to the increasing demand on companies to embrace sustainable practices such as using Green ICT. This study provides insights into the challenges faced by telecommunications organisations in the country when implementing green practices. The transition to green technology is vital for addressing environmental challenges, reducing carbon dioxide emissions and meeting sustainability goals, including SDGs seven, nine, 11, 12 and 13 in SA. The study focused on technology employees at Organisation A. The adoption of environmentally friendly technology, characterised by the advancement of energy-efficient products and reduced energy usage by corporations, holds immense significance not only in terms of environmental preservation and energy preservation, but also presents considerable financial benefits for organisations (Klopper & Meyer, 2020).

The significance of this study stems from its potential to enhance the understanding of the challenges and enablers related to the adoption of Green ICT within the telecommunications sector in SA. The knowledge gained could guide organisational and governmental bodies in strategic decision-making and policy formulation aimed at advancing sustainability in the industry and potentially supporting Organisation A's Green ICT plan. This study's importance lies in its contribution to the body of knowledge on Green ICT. The suggested approach may be adaptable across different sectors, allowing the research findings to serve as a roadmap for other telecommunications organisations globally adopting Green ICT. Understanding these challenges and facilitators could generate societal benefits, including the creation of green technology jobs, a reduction in energy costs and an enhancement of business reputation due to improved sustainability practices.

## 1.4 THE AIM AND PURPOSE OF THE STUDY

The aim of the study was to identify the primary challenges to transitioning to Green ICT in a telecommunication organisation in SA as well as determining the factors that supported it. The purpose of the study was to develop efficient plans or solutions that could assist the

organisation in overcoming these challenges and facilitating a more seamless transition to Green ICT.

## 1.5 PROBLEM STATEMENT

Despite Organisation A's objective to achieve a 50% reduction in its greenhouse gas emissions by 2025, the organisation has observed a 4.5% increase in emissions from the financial year (FY) 2021 to 2022, primarily due to increased data traffic, extended power outages (load shedding) leading to increased diesel consumption and strengthened efforts in energy reporting (Sustainable Report, 2022). In response to grid-supplied electricity limitations, notably from load shedding in SA and issues in the Democratic Republic of Congo (DRC), Organisation A's group's diesel consumption increased to 45 million litres from 40 million in FY2022, primarily used for generators at remote or inconsistent power sites (Integrated Report, 2023). The pursuit of net-zero, imperative for mitigating climate change and restricting global warming to 1.5°C, demands an overarching change in humanity's production, consumption and transportation frameworks; with a serious emphasis on transitioning from fossil fuels, the principal contributor to greenhouse gas emissions, to renewable energy within the energy sector (United Nations, 2023).

Globally, a shift in economic strategies is underway, with dual importance on securing reliable energy and maintaining environmental sustainability; though the achievement of these combined objectives is impeded by existing technological inefficiencies (Murshed, 2020). The United Nations (UN) highlights an escalating global consensus to improve environmental conditions through the curbing of carbon dioxide (CO2) emissions and promoting sustainable development as a response to the environmental crises induced by the unsustainable exploitation of the earth's finite resources (Imasiku, Thomas & Ntagwirumugara, 2019). In response to Conference of the Parties' (COP) 26 commitments, the growing demand for sustainable goods and services and the need to integrate sustainability into the rapid digital transformation of organisations have become more critical, given that digital technology now also poses environmental challenges (Abdullai, Sipilä & Porras, 2022).

According to a study conducted by Hankel et al. (2019) on three organisations in the Netherlands, the key challenge in achieving environmental improvements via Green ICT implementation is the necessity of a systemic approach that engages all relevant parties. Further

investigation is necessary into the application of sustainable digital transformations within organisations; specifically comparing those operating in countries with established governmental climate strategies for the ICT sector and those functioning in nations without such sustainable ICT policies (Abdullai et al., 2022). Despite the significant environmental impact of IT operations, including high electricity consumption and hazardous e-waste production, the potential of Green IT remains under-researched, underscoring the urgent need for developing a comprehensive Green IT framework and strategies within organisations (Klopper & Meyer, 2020). According to the study conducted in Finland by Abdullai, Sipilä, and Porras (2022), there is a significant shortfall in awareness of Green ICT and the corporate strategies for its adoption are often nebulous.

In light of Organisation A's commitments to the Paris Agreement and net-zero targets, their failure to effectively transition to a more sustainable business model within the specified timeframe poses significant risks, considering SA's transition to a low-carbon economy driven by the displacement of fossil fuel energy, adoption of renewable energy technologies and the reduction of greenhouse gas emissions (TFCD, 2022). As cited by Organisation A, failing to meet the requirements for transitioning to green efficiency poses risks such as policy and legal risks, technological risks, market risks and risks to the company's reputation (TFCD, 2022).

The group Chief Executive Officer (CEO) of Organisation A articulates Organisation A's enthusiasm for aiding Africa's evolution towards a low-carbon region while affirming their ongoing commitment to identifying avenues that would bolster their customers' efficiency endeavours (TFCD, 2023). Organisation A's current implementation of onsite renewable energy stands at less than 1%, highlighting the need for an expedited pace to achieve their environmental targets. This research aimed to identify the primary challenges to transitioning to Green ICT in a telecommunication organisation in SA and to determine the factors that supported Green ICT implementation in the telecommunications sector.

## 1.6 RESEARCH QUESTIONS

In order to examine and solve the research problem, the following research questions have been posed:

### 1.6.1 Main research question

The main research question for this study is:

- What are the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT?

### 1.6.2 Research sub-questions

In order to address the main research question, the subsequent secondary research questions must be answered:

- What is the current state of Green ICT adoption within Organisation A?
- What are the specific challenges and barriers that impact Organisation A's transition to Green ICT?
- What is the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A?
- What strategies can be recommended to Organisation A to address both the challenges and barriers in their Green ICT implementation process?

## 1.7 RESEARCH OBJECTIVES

In order to answer the above research questions, the following research objectives are presented.

### 1.7.1 Primary objectives

- To identify the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT.

### 1.7.2 Secondary objectives

- To evaluate the current state of Green ICT adoption within Organisation A.
- To investigate the challenges and barriers that impact Organisation A's transition to Green ICT.

- To determine the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A.
- To provide recommendations on strategies for Organisation A to overcome challenges and barriers in their Green ICT implementation process.

### 1.7.3 Hypothesis

A hypothesis, created after a comprehensive literature review, is a provisional assumption set forth to test its logical or empirical implications, serving as the central focus for research (Pandey & Pandey, 2015).

The following research hypotheses have been formulated to address the research objectives and provide insights into the primary challenges, current state and employee perceptions regarding Green ICT adoption in Organisation A. These hypotheses are structured to answer all research objectives except for the recommendations, which will be derived from the study findings.

- **Hypothesis H1:** The current state of Green ICT adoption in Organisation A is suboptimal.
- **Hypothesis H2:** There are significant challenges and barriers impacting Organisation A's transition to Green ICT.
- **Hypothesis H3**: A higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A.

## 1.8 RESEARCH DESIGN AND METHODOLOGY

This study follows a structured research design, which serves as a blueprint for data collection and analysis. The research methodology outlines the theoretical and philosophical framework guiding this study, which follows a quantitative approach. The research design encompasses key methodological components; including the research philosophy, research approach, population and sampling process, data collection methods, data analysis techniques, pilot study, reliability and validity measures, ethical considerations and study limitations. These aspects ensure a systematic and rigorous approach to investigating Green ICT adoption in

Organisation A**.** A more detailed explanation of these methodological choices is provided in Chapter 4**.**

This study is grounded in the positivist paradigm, which assumes an objective reality that can be measured scientifically. Positivism enables the researcher to analyse observable social phenomena and formulate generalisations similar to those in the natural sciences. The study adopts a deductive research approach, which involves deriving hypotheses from theory and testing them through empirical data collection. By employing this approach, the research objectively examines the challenges associated with the transition to Green ICT in Organisation A through quantifiable methods. A more detailed discussion of the research philosophy and approach is provided in Chapter 4, Section 4.3**.**

The research design serves as a structured roadmap that guides data collection and analysis. This study adopts a quantitative approach, allowing for the systematic examination of relationships between measurable variables. The descriptive research design is utilised to quantify and analyse the challenges associated with transitioning to Green ICT in Organisation A. A survey strategy is used to gather standardised data from a subset of technology employees, providing insights that can be generalised to the broader population. Additionally, a cross-sectional time horizon is applied, capturing data at a specific point in time to assess prevailing challenges and trends. A more detailed discussion of the research methodology and strategy is provided in Chapter 4, Sections 4.5 and 4.6**.**

This section provides an overview of the population and sampling process used in the study. The target population consists of 1,282 ICT professionals and senior-level managers within Organisation A, who are actively involved in ICT processes and the transition to Green ICT. Since studying the entire population is impractical, a sample size of 297 was determined using a 95% confidence level, 5% margin of error and the finite population correction factor formula**.** The study employs probability sampling, specifically simple random sampling**;** ensuring each participant has an equal chance of selection, reducing bias and enhancing the reliability of the findings. More detailed discussions on population and sampling are provided in Chapter 4, Section 4.8**.**

This study employed a structured questionnaire as the primary data collection instrument to gather quantitative data on the transition to Green ICT within Organisation A. The

questionnaire included predominantly closed-ended questions, with one open-ended question to provide additional insights. It was designed to assess the current state of Green ICT adoption, the challenges faced and potential strategies for improvement.

The questionnaire was structured into six sections, aligning with key research constructs. A consent form was incorporated to enhance participant understanding and ensure informed consent. The questionnaire was self-administered via email to the identified technology employees within Organisation A to facilitate efficient data collection. Further details on data collection methods and procedures are provided in Chapter 4, Section 4.9.

A structured questionnaire was designed and utilised as the main tool for data collection, featuring predominantly closed-ended questions, with one open-ended question to capture additional insights. The questionnaire utilised a five-point Likert scale to ensure standardised responses and it was self-administered via email to technology employees within Organisation A. A consent form was included to explain the research objectives, enhance participant understanding and obtain informed consent.

Data analysis was conducted using Stata version 19, applying descriptive and inferential statistical techniques. Descriptive statistics summarised the dataset, while inferential methods, including t-tests, correlation analysis and regression analysis, examined relationships between variables and tested the study's hypotheses. Effect sizes were also calculated to assess the practical impact of the findings. This quantitative analysis approach facilitated the extraction of meaningful insights and supported evidence-based conclusions on the transition to Green ICT. Further details on the data collection and analysis process are provided in Chapter 4, Section 4.10**.**

A pilot study was conducted to assess the validity and reliability of the research instrument before full-scale data collection. The pilot testing aimed to evaluate content validity, internal consistency and potential participant fatigue to enhance the overall quality of the questionnaire. The process involved 15 participants who were selected to test the questionnaire's clarity, structure and suitability.

Feedback from the pilot study was used to refine the questionnaire, identify ambiguities and ensure that all questions were relevant and easy to understand**.** Additionally, the study helped

estimate costs, refine methods and assess variations within the target population. More details on the pilot study are provided in Chapter 4, Section 4.11.

## 1.9 VALIDITY AND RELIABILITY

To ensure the validity of this study, descriptive statistics were used to provide an overview of the data; inferential statistics, including correlation and regression analysis, were employed to analyse relationships between variables. Data analysis was conducted using Stata version 19 and effect sizes were calculated to measure the practical significance of findings. Standardised administration was ensured through Lime Survey, contributing to the consistency of data collection.

For reliability the questionnaire was carefully designed and randomisation was applied during its administration. The sample size was appropriately determined and data quality monitoring was conducted. Both descriptive and inferential statistical techniques were used to enhance the reliability of the findings. The collected data is securely stored and will be retained for five years**.**
More details on validity and reliability are provided in Chapter 4, Section 4.12**.**

## 1.10 ETHICAL CONSIDERATIONS

Ethical approval for this study was obtained from the College of Economics and Management Sciences at UNISA, ensuring compliance with the university's research ethics policies. Permission to conduct the study was also granted by Organisation A's Public Affairs department and the designated gatekeeper. Participants and organisation management received a consent form detailing the study's purpose and participation was voluntary. Confidentiality was maintained by excluding names from the questionnaire and securely storing all study documents in a locked or password-protected environment. More details on ethical considerations are provided in Chapter 4, Section 4.13**.**

## 1.11 EXPOSITION OF CHAPTERS

The following section provides an overview of the structure of this study, outlining the key focus of each chapter.

### 1.11.1 Chapter 1: Introduction

Chapter 1 of this study introduces the background and conducts a preliminary literature review, highlighting the significance of the research, purpose, research problem, research questions, research objectives and key concept definitions. It also presents the study's objective, explores relevant historical information and provides a comprehensive understanding of key elements, contributions and the defined research methodology.

### 1.11.2 Chapter 2: Literature review A

Chapter 2 of this research presents a thorough literature review, encompassing a comprehensive analysis of existing scholarly works and relevant sources related to the research topic. The chapter critically examines and synthesises the literature to establish the current state of knowledge, identify research gaps and develop a theoretical framework specific to the research.

### 1.11.3 Chapter 3: Literature review B

Chapter 3 of this research presents a review of underpinning theories that illuminate the dynamics of technology adoption. A comparative analysis was conducted on several foundational models, systematically assessing their relevance to Green ICT adoption. After a thorough evaluation the Green Information Technology Adoption Model (GITAM) was selected as the most suitable framework due to its comprehensive approach; integrating key factors such as technology, organisation, environment, readiness, drivers and adoption intentions.

### 1.11.4 Chapter 4: Research methodology

Chapter 4 of this study presents the research methodology utilised specifically for quantitative analysis. The chapter outlines the chosen research design; the data collection methods focused on structured questionnaires and the sampling techniques employed.

### 1.11.5 Chapter 5: Findings of the study

Chapter 5 of this study will present the results obtained from the research. The findings will be presented using various formats, such as charts, tables and graphs, to enhance the

understanding and visualisation of the data. Calculations derived from the software used for analysis will also be included. The results will be analysed in relation to the literature review, allowing for comparisons with previous studies and facilitating the drawing of conclusions. The chapter aims to provide a comprehensive and meaningful interpretation of the research outcomes.

### 1.11.6 Chapter 6: Conclusions and recommendations

Chapter 6 provides a comprehensive summary of the research results, their interpretations and their alignment with the study objectives. The findings are critically analysed and linked to the research questions to assess their adequacy. Additionally, this chapter offers valuable recommendations and suggestions for future research based on the obtained results. It concludes with a concise overview of the study's conclusions and highlights potential areas for further investigation.

## 1.12 CONCLUSION

This chapter introduced the study by presenting the background and context, problem statement, research questions, objectives, significance and methodological framework. It established the rationale for exploring Green ICT adoption within the South African telecommunications sector, highlighting the urgent need to address environmental challenges while supporting digital expansion. The study is underpinned by the Green Information Technology Adoption Model (GITAM), which provides the theoretical foundation for explaining and predicting the adoption of Green ICT practices within organisations.

In addition, the chapter outlined the research design, approach and data collection strategy, ensuring methodological rigour and providing the basis for reliable findings. The scope, motivation and importance of the study were emphasised, illustrating its potential academic and practical contributions; particularly in advancing knowledge on sustainability in ICT.

The next chapter presents Part A of the literature review of this study

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 INTRODUCTION

A literature review presents a thorough summary and synthesis of previous studies related to a specific theme, theory or method; enhancing the foundational knowledge in the field (Paul & Criado, 2020). Literature reviews form the backbone of research by forming a knowledge base, shaping policy and practise guidelines, demonstrating evidence of effects and potentially encouraging new ideas and directions in a specific field, thus laying the groundwork for future research and theoretical development (Snyder, 2019). According to Paul and Criado (2020), a review assesses widely used theories, structures and methodologies in a variety of contexts to pinpoint research gaps. It also provides recommendations for future research that include creative ideas and research questions, serving as a springboard for more studies (Paul & Criado, 2020). A comprehensive literature review, essential across research fields for embedding a study within its academic context, involves a systematic and critical synthesis of existing research to establish and confirm the study's purpose, objectives and hypotheses; ensuring precision, relevance and credibility (Snyder, 2019).

A metaphorical golden thread should ideally run through the aims, objectives, hypotheses or key questions; this is accomplished when the key questions contribute to meeting the objectives, which in turn facilitates the accomplishment of the primary aim (Fabricius, Roux, Barendse & Currie, 2014). Consequently, this section presents a review of existing literature on the four main constructs namely, ICT, Green ICT, the telecommunications industry and the organisation under study (Organisation A). Chapter 3 will review the underpinning theories informing this study and it will provide the motivation for the selected theory that underpins this research. In order to investigate the main challenges faced by a South African telecommunications organisation throughout its transition to Green ICT, this chapter undertakes a thorough review of recent literature.

The first section defines the breadth and influence of ICT, demonstrating its applicability in the technologically advanced and sustainable world of today. The idea of "Green ICT" also known as GICT is then examined, along with its significance and the need for its adoption in

response to environmental issues. It also covers the challenges and barriers associated with making the transition to GICT, as well as GICT practices and technologies globally and in developing nations. The discussion then progresses to the South African telecommunications industry, its significance for the development of a country and its effects on the environment. Globally recognised ICT organisations are dedicated to making the transition to GICT and are a key component of the country's shift towards sustainable technology. As the chapter concludes Organisation A, the leader in African telecommunications, is developing into a digital technology company with a strong focus on sustainability. As part of its broad strategy for innovation and environmental responsibility, Organisation A aims to overcome challenges in the transition to GICT.

Insights into the primary objectives are derived from global experiences, with specific details on challenges and barriers highlighted in Section 2.4.3. This section provides a global overview of obstacles that hinder the adoption of sustainable ICT practices, which in turn helps to frame the specific research questions aimed at uncovering the unique challenges faced by Organisation A. The content of Figure 2.1 below presents the structure for this chapter.

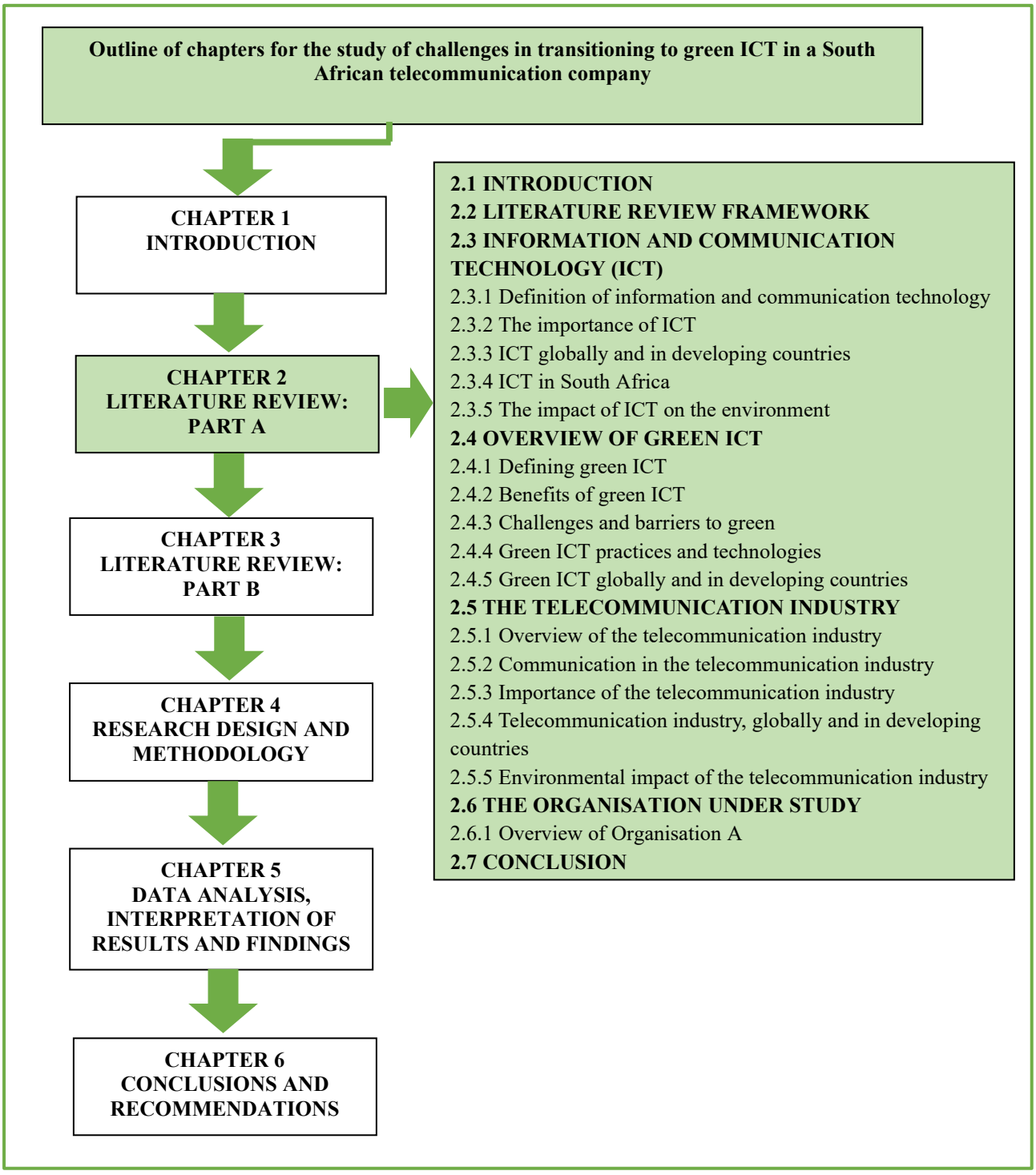



**Figure 2.1**: Outline of Chapter 2
**Source:** Author's compilation (2024)

## 2.2 LITERATURE REVIEW FRAMEWORK

Figure 2.2 outlines the study's title and structures the chapter, focusing on the main constructs: ICT, Green ICT, the telecommunications industry and the organisation under study. These constructs form the variables of the chapter, presented within a conceptual framework that provides an integrated perspective on the addressed issue. A thorough assessment of previous studies and publications pertaining to a certain topic or research issue is another definition of a literature review. It is carried out using a structured approach called a framework, which enables researchers to methodically gather, assess and synthesise existing knowledge to comprehend the state of research at the moment and spot gaps in the body of literature.

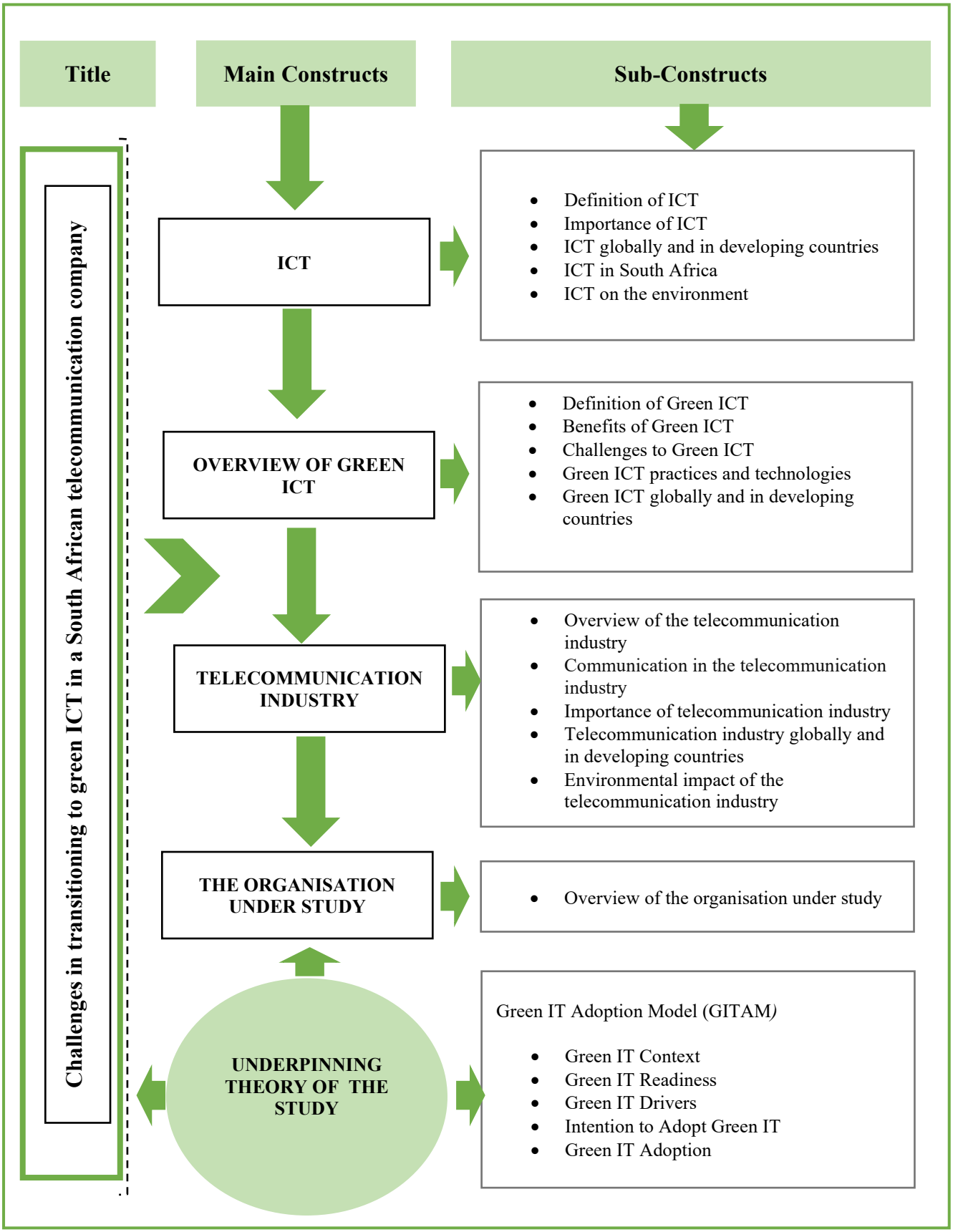



**Figure 2.2:** Literature review framework

**Source:** Author's creation (2023)

## 2.3 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

ICT exerts a significant impact across every area of knowledge and serves as a driving force in various human activities (Haneefa & Saranya, 2020). The ICT sector's rapid growth has brought attention to its environmental impact, particularly the carbon emissions it produces throughout the life cycle of a product, which contribute to climate change (Freitag et al., 2021). ICT plays a significant role in this study as it is examined for current practices, offers potential green solutions, promotes the shift to environmentally sustainable practices and serves as a tool for tracking and evaluating the performance of GICT efforts. The following sub-constructs in this study will delve into the following components: definition of ICT, the importance of ICT, ICT globally and in developing countries, ICT in SA and the impact of ICT on the environment. The literature review on this main construct is significant as it relates to the first secondary objective of this study, which seeks to determine the current state of GICT adoption within Organisation A.

### 2.3.1 Definition of information and communication technology

ICT is essentially comprised of software, hardware, networks and media, extensively utilised for gathering, interpreting, processing, storing and transmitting information in various formats such as voice, data, text and images; while also providing several other services, all under its two principal components: Information and Communication Infrastructure (Al-Rahmi et al., 2020). ICT includes all types of similar infrastructure that permits users to store and send data; it connects the world (Hu, Chen & Yang, 2022). Due to ICT being a commonly used technology, it is basically used in practically every activity in an organisation (Hankel et al., 2019). ICT has essentially become a necessity in modern life, opening novel opportunities for learning, communication, economic development and sustainability.

### 2.3.2 The importance of ICT

Since the dawn of ICT, the global economy has been influenced in many ways, such as: easy-to-use e-commerce platforms, which created new markets in remote areas and removed access barriers in the markets; economic and social assistance in education, health and trade and proficient production methods (Zafar et al., 2022). ICT is important as it accelerates and simplifies the challenging processes involved in creating, storing and gaining access to data for

both present and future use (Islam et al., 2020). Furthermore, the importance of ICT is displayed as a key accelerator for economic development in countries because of the easy access to information, efficient use of resources, economic integration, employment creation and productivity improvements it offers (Hussain, Batool, Akbar & Nazir, 2021). Another example of the importance of the ICT industry is that it plays an essential function in helping a country achieve its objective of being developed (Islam et al., 2020). To display the importance of ICT, the United Nations (UN) has recommended that developing countries should utilise ICT across a variety of sectors, including health, transportation, government organisations, education, agriculture, training and service departments, among others; as it has the potential to improve revenue generation, raise living standards, reduce unemployment, increase productivity, foster market efficiency, control price fluctuations, lower transaction costs, encourage investment and facilitate knowledge creation (Hussain et al., 2021).

A study by Dawadi, Rawat, Joshi and Keitsch (2020) highlights the importance of ICT in enhancing social welfare, economic development and governance in developing countries like Nepal and discusses the challenges of rural ICT deployment due to difficult terrain, economic disparity and urban-centric private services. ICT can help South Asia cut carbon emissions and boost sustainability via improved governance and healthcare, renewable energy and regional collaboration; though further research is needed to refine policies in light of its current environmental footprint (Aldakhil, Zaheer, Younas, Nassani, Abro & Zaman, 2019). The study by Zhang et al. (2022) suggests that ICT will eventually enhance the quality of the environment in developing countries by increasing efficiency in industries like energy and transportation, promoting more investment in ICT infrastructure to close the demand-supply gap in rural areas and encouraging the financial sector to support green investments by lowering interest rates.

The growth of ICT has changed the way people interact, work, study and access information. The widespread use of ICT has become a major driving force in facilitating daily business routines, especially during tough economic times, as it enables the proficient utilisation of economic resources, accelerates the pace of economic development and helps countries reap the benefits of knowledge-driven economies (Hussain et al., 2021). ICT ability can be used in organisations to improve their environmental performance so they can meet regulations and enhance profits and competitiveness in the marketplace (Antoni, Abareshi, Jenderal & Yani, 2020).

ICT is reshaping employment by producing new jobs and transforming current ones; necessitating that countries focus on education and the development of digital competencies to remain competitive (World Bank, 2023). ICT acts as a paradox in the modern world, driving economic growth and opportunity while also contributing to environmental challenges with an estimated 1,100 million metric tonnes of carbon emissions, yet it also plays an essential role in encouraging environmental sustainability by enabling smart IoT solutions that reduce carbon emissions in various sectors such as logistics, traffic, education, health and agriculture (Popli, Jha & Jain, 2021). The potential exists for ICT developments to rapidly and gradually produce sustainable outcomes when combined with green innovations and technologies (Zafar, Zhilin, Mabrouk, Ramirez-Asis, Alzoubi, Hishan & Michel, 2023). The important role played by ICT in promoting sustainable and inclusive development cannot be overstated and it is imperative to acknowledge its significance in advancing diverse sectors of human life (Ukhurebor, Nwankwo & Olayinka, 2020). As a result, ICT has grown in popularity and accessibility, facilitating communication, education and commerce globally.

The internet is a good indicator for comparing ICT coverage globally, as internet access is a key component of ICT infrastructure. The internet's rapid development has substantially increased the utilisation of ICT (Islam et al., 2020). Technological advancements, such as artificial intelligence (AI), the internet of things (IoT), fourth-generation wireless (4G) and the anticipated commercial rollout of fifth-generation wireless (5G), have been instrumental in driving the surge in communication traffic data, highlighting the importance of ICT in this growth (Zhang et al., 2022). Figure 2.3 shows that an estimated 67% of people are using the internet globally.

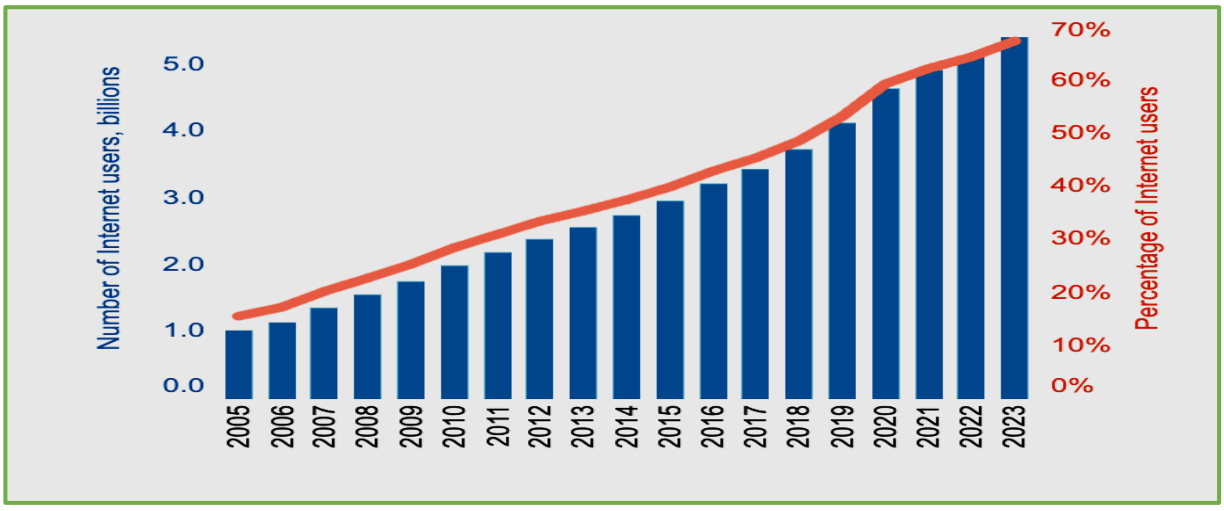



**Figure 2.3:** Individuals using the internet globally

**Source:** ITU (2023a)

According to the ITU, in 2023, an estimated 5.4 billion individuals, constituting 67% of the global population, will have internet access, marking a 45% surge since 2018; with about 1.7 billion new users in this interval Yet around 2.6 billion people worldwide remain without internet connectivity (ITU, 2023a). The sharp increase in global internet usage, as depicted in Figure 2.3, highlights the importance of ICT, underscoring the role of digital connectivity as a critical driver for socio-economic development and reinforcing the urgency for inclusive strategies to bridge the digital divide for the remaining 2.6 billion individuals still without internet access. Understanding the importance of ICT is essential for identifying and overcoming the barriers that Organisation A faces in its transition to Green ICT, thereby enabling more sustainable and efficient business operations. This literature review on the importance of ICT as well as the concluding statement is relevant as they align succinctly to the primary objective of the study which is to determine the primary barriers facing a SA telecommunications organisation in transitioning to Green ICT.

### 2.3.3 ICT globally and in developing countries

In 1994, with approximately 20 million internet users representing less than half a percent of the global population, internet penetration saw double-digit growth rates until it reached 29% in 2010 (ITU, 2022). ICT in sustainable economic development has become vital for nations seeking well-balanced growth, as telecommunications technology and innovation serve as key modern infrastructure supporting sustainable economic growth (Maneejuk & Yamaka, 2020). ICT plays a major role in organisations and is utilised in many global organisations where a high demand for electronic devices is present (Ara, 2018). In 2018, Nepal's internet penetration exceeded 50%, presenting service providers with the chance to extend their reach into rural areas; subsequently this increase in ICT access poses the challenge of higher energy consumption, which calls for a greener ICT infrastructure for sustainable management (Dawadi et al., 2020). In 2020, approximately 466 million people started using the internet for the first time, resulting in a 10.3% rise in penetration (ITU, 2022). The growth continued steadily until the COVID-19 pandemic caused a significant increase in internet usage (ITU, 2022). South Asian countries have shown impressive advancement in embracing ICT and they are now the fastest-developing countries in the region (Hussain et al., 2021). In 2021, internet penetration rates displayed considerable variation, ranging from 6% in Burundi to 86% in Bhutan, a level

similar to many advanced economies; by 2022, these rates were 53% for the single least developed countries in the Americas, 43% across the 12 least developed countries in Asia and the Pacific and an average of 28% for the 33 least developed countries in Africa (ITU, 2023b).

In 2022, 36% of the least developed countries (LDC) were using the internet, compared to 66% globally (ITU, 2023b). In 2011, internet usage in LDC experienced a remarkable surge, jumping from 4% to 36% of the population, with a compound annual growth rate of 22%, over three times the global growth rate of 7.2% (ITU, 2023b). The 720 million people remaining offline in LDC constitute 27% of the worldwide offline population, despite the LDC population making up just 14% of the global population (ITU, 2023b). The middle-class growth in the world has prompted a substantial increase in ICT product utilisation (Hatzivasilis, Christodoulakis, Tzagkarakis, Ioannidis, Demetriou, Fysarakis & Panayiotou, 2019). ICT devices have increased exponentially around the world over the past few decades (Atsu et al., 2021).

In 2022, a stark digital divide persisted, with over 90% of individuals in high-income countries using the internet, contrasting with just a quarter in low-income countries and as of 2023, 2.6 billion people remain unconnected; with 850 million lacking identification and necessary internet skills, while the World Bank's initiative is focused on initiating digital transitions in developing nations, emphasising that digital technologies are crucial for addressing global challenges, creating jobs, improving financial access and increasing efficiency and transparency (World Bank, 2023). The current state of ICT globally and in developing countries underscores the need for research into Organisation A's GICT transition to consider the global digital landscape and the unique challenges faced by developing countries, aligning with the research objective to evaluate current adoption levels and to develop strategies for inclusive, environmentally sustainable technological growth. Additionally, SA has experienced rapid ICT growth as discussed below.

### 2.3.4 ICT in South Africa

In 2000, SA internet connectivity was 5.8%, rising to 24% in 2010 and to 56% by 2016, while the Sub-Saharan African (SSA) average increased from less than 1% in 2000 to 7% in 2010 and to 24% in 2017; additionally, SA mobile phone connectivity surpasses 150% of the population, compared to the region's average of 87 per 100 people (Atsu et al., 2021). In 2022,

total telecommunications investment rose by 17.16% to R39.7 billion from R33.9 billion in 2021, while national population coverage reached 100% for 3G, 98% for 4G/LTE and increased from 7.5% to 20% for 5G (ICASA, 2023). Total mobile cellular subscriptions surged by 40.91% to 145 million in 2022, up from 103 million in 2021, while prepaid mobile-cellular telephone subscriptions experienced 2.86% growth during the same year (ICASA, 2023). Figure 2.4 shows 72.3% of people are using the internet in SA compared to 35.3% in Africa.

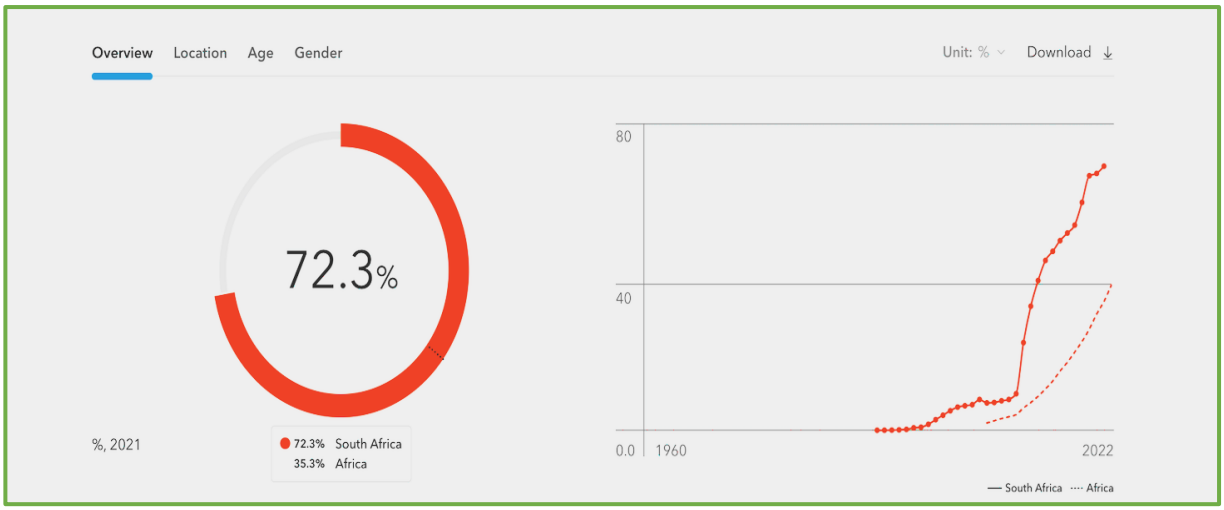



**Figure 2.4:** Individuals using the internet in Africa
**Source:** ITU (2023a)

In 2021, internet usage among individuals in SA was 72.3%, surpassing the global average of 62.6% (ITU, 2023c). This suggests that the country has made meaningful strides in expanding internet accessibility and promoting digital literacy among its population. According to Figure 2.4, in 2021 72% of individuals in SA used the internet, whereas, on the African continent, the percentage of individuals using the internet stood at 35.3% (ITU, 2023a). SA, featuring one of Africa's largest ICT markets, is a leader in mobile software, security software and electronic banking services, contributing significantly to its Gross Domestic Product (GDP) and hosting subsidiaries of several international corporations, illustrating both the sophistication and ongoing development of its ICT and electronics sector (ITA, 2023). Loadshedding in SA in 2022 significantly affected the ICT sector, leading to a reliance on alternative power sources, with licensees spending R2.6 billion on batteries and R873 million on generators, resulting in the purchase of 16,660 generators and 98,733 batteries. Yet, despite these challenges, the telecommunications and broadcasting services saw revenue increases of 3.94% and 11.97%, respectively (ICASA, 2023). SA has been rapidly increasing its ICT devices compared to the

other SSA countries over the past few years, making SA highly advanced in the ICT infrastructure in SSA (Atsu et al., 2021). The higher internet usage in SA, compared to the global average and the African continent, also highlights the country's progress in bridging the digital divide. This makes SA one of Africa's most advanced countries in terms of ICT infrastructure and provides a pertinent backdrop for investigating Organisation A's adoption of GICT; making it an important study for understanding and enhancing sustainable ICT practices on the African continent.

### 2.3.5 The impact of ICT on the environment

Human activities have impacted climate change through increased greenhouse gases; leading to global health issues, particularly in Africa, and an increase in global temperatures (Mikhaylov, Moiseev, Aleshin & Burkhardt, 2020). Global health, biodiversity and agriculture are all affected by climate change, this impacts tourist destinations owing to weather changes and increases the risk of disease and antimicrobial resistance (Abbass, Qusim, Song, Murshed, Mahmood & Younis, 2022). Human growth, governed by ecological principles, faces environmental limits, but human adaptability and heavy fossil fuel use disturb the earth's delicate balance, impacting sustainability issues (Caineng, Feng, Songqi, Minjie, Ying & Zhi, 2022). At the 2023 United Nations Climate Change Conference or Conference of Parties (COP28) in Dubai, negotiators agreed on significant steps towards ending the fossil fuel era. This included a 'global stocktake' to enhance climate action by 2030, setting targets for reducing greenhouse gas emissions, increasing renewable energy and energy efficiency and establishing a loss and damage fund; while underscoring the need for greater financial commitments and collaborative efforts across nations, businesses and civil society for a sustainable future (UNFCCC, 2023). Human actions are amplifying climate change, resulting in worldwide issues, and jeopardising the foundation of civilisation. The environmental balance that formerly enabled civilisations to flourish is at risk due to human activity, which may result in dangerous changes in the planet's natural dynamics (Miraux, 2022). Environmental disasters are exacerbated by climate change, which raises ocean temperatures and sea levels, increases the likelihood of flooding and extreme weather events like hurricanes and promotes droughts resulting in wildfires and agricultural problems (Smith, Anjum, Francis, Deanes & Acey, 2022).

ICT has increased rapidly in the last 70 years and has now become a concern regarding its effects on climate change; with its increasing carbon footprint causing greenhouse gases to be released from all stages of its life cycle, which includes manufacturing, operation and the disposal of e-waste (Freitag et al., 2021). The rapid growth of the internet has significantly increased the use of ICT, raising concerns about the environmental sustainability of the industry in terms of carbon emissions, substantial electricity consumption and inadequate e-waste management practises (Islam et al., 2020). Raihan's (2023) study suggests that, as ICT develops, a temporary monitoring strategy for internet usage be implemented to control its ecological effects. The constant increase in the requirement for processing and computing power has resulted in more data centres, higher carbon emissions, unethical waste management, a high requirement for energy and the reduction of natural resources (Anthony, Abdul Majid & Romli, 2018).

Large organisations are always trying to gain a competitive advantage over their competitors by growing their ICT infrastructure, while simultaneously failing to understand the dangers it is causing to the environment (Ukhurebor et al., 2020). Global ICT manufacturing has increased as a result of the sharp rise in ICT demand and market competition. Developed countries annually discard vast amounts of e-waste without recycling or repurposing; often resulting in landfill dumping, incineration or export to developing nations (Airehrour, Cherrington, Madanian & Singh, 2019). The growing demand for equipment like sensors, edge computers, data servers and 5G devices to support future ICT services, while driving economic growth and enhancing daily life conveniences, raises concerns about a substantial increase in energy consumption (Zhanget al., 2022). Research by Avom, Nkengfack, Fotio and Totouom (2020) finds that, although trade openness has a mitigating effect, ICT ultimately contributes to higher carbon dioxide (CO2) emissions in Sub-Saharan Africa through the energy and financial sectors, which lowers environmental quality.

Consequently, ICT is both a contributor to environmental burdens but also offers potential solutions for it (Gonel & Akinci, 2018). ICT enables remote work to reduce travel-related Green House Gas (GHG) emissions, aids in sharing services to decrease raw material usage and improves production efficiency by minimising intermediate raw material input (Zhang et al., 2022). ICT in South Asia has a mixed impact, with infrastructures like fixed telephone subscriptions and service information society increasing CO2 emissions and energy consumption, while mobile cellular subscriptions could potentially lower them; this is set

against the backdrop of the Environmental Kuznets Curve, which indicates that environmental degradation initially worsens but then improves as income levels rise (Aldakhil et al., 2019). Raihan's (2023) study reveals that in Malaysia a 1% increase in internet usage slightly increases greenhouse gas emissions by 0.013% but this is offset by a larger, long-term decrease of 0.077%. It also emphasises the importance of integrating ICT with green practices, dematerialisation, renewable energy policies and economic strategies to enhance energy efficiency and reduce environmental impact. N'dri, Islam and Kakinaka's (2021) study posits that the positive environmental impact of ICT, particularly through energy efficiency and savings, is likely to surpass its negative aspects like increased energy consumption; suggesting that advancing ICT development, coupled with green initiatives and foreign investment in sustainable technologies, is key for developing countries to address environmental challenges and meet climate goals. ICT is portrayed as a double-edged sword, propelling economic development and opportunities while simultaneously imposing a significant environmental cost by contributing approximately 1,100 million tonnes of carbon emissions (Popli, Jha and Jain, 2021).

ICT emissions have continuously increased alongside global emissions and is continuously growing its carbon footprint, which is shown to increase greenhouse gases by 1.8% a year, which is approximately 20 percent per decade (Freitag et al., 2021). The negative environmental impact of ICT can be reduced by implementing GICT. Avom, Nkengfack, Fotio and Totouom's (2020) study supports the environmental Kuznets curve theory, which correlates CO2 emissions with economic growth in Sub-Saharan Africa and advocates for the improvement of energy efficiency, the advancement of renewable energy, support for green technology and the bolstering of public awareness as strategies to mitigate the ecological impacts of ICT. 'Digital sufficiency' is described as a comprehensive strategy to reduce ICT's environmental impact through enhanced efficiency, reformed production methods, altered consumption patterns and strict policy application in hardware, software and fiscal areas. All while incorporating these efforts into broader environmental policies to respect ecological limits and reduce emissions (Santarius, Bieser, Frick, Hojer, Gossen, Hilty, Kern, Pohl, Rohde, Lange, 2023). Efforts to reduce ICT's environmental impact are underway by developing GICT infrastructure, such as energy-efficient data centres and mobile networks, energy harvesting technologies, user devices that consume less energy and a 5G network designed with environmental sustainability in mind (Popli et al., 2021).

The secondary research objectives, such as evaluating the current state of Green ICT adoption within Organisation A and investigating the challenges and barriers impacting the transition, align directly with understanding 'The impact of ICT on the environment'. Additionally, providing strategic recommendations to enhance Green ICT practices emphasises a commitment to fostering sustainable technological advancements. The next section presents the literature review on an overview of Green ICT.

## 2.4 OVERVIEW OF GREEN ICT

Green ICT, or greening ICT, refers to the practice of using electronic and communication devices in ways that maximise environmental benefits and efficiency while developing computing solutions that are both environmentally sustainable and operationally effective (Adimoolam, John, Balamurugan & Kumar, 2021). Throughout the lifecycle of ICT devices, GICT actively encourages environmental sustainability. It focuses on energy efficiency, resource conservation and efficient e-waste management to minimise the environmental impact of every stage of production, from design through disposal. GICT has gained global acceptance and stakeholders are becoming increasingly concerned with reducing waste, energy use and carbon footprints through careful planning and an array of green initiatives and policies (Dalvi-Esfahani, Alaedini, Nilashi, Samad, Asadi & Mohammadi, 2020). GICT has environmental benefits but it can also save costs and improve productivity. Given its importance, it is an essential topic of research for the planet's future. Integrating green practices into business strategies can aid organisations to reduce energy consumption and greenhouse gas emissions and gain a competitive edge, while IT vendors simultaneously strive for innovative solutions to address the energy consumption of electronics (Sargam & Gupta, 2022). The following sub-constructs in this study will delve into the following components: defining Green ICT, the benefits of Green ICT, Green ICT practices and technologies and Green ICT globally and in developing countries.

### 2.4.1 Defining Green ICT

Thabit, Aissa and Jasim (2021) defines Green Information and Communication Technology (Green ICT) as a concept that explores the potential of ICT to reduce environmental impacts through smarter purchasing and usage; while also enhancing the efficiency of various processes through the adoption of smart technologies. The concept of Green IT (Green ICT) was born in

1992 when the United States Environmental Protection Agency (USEPA) introduced the Energy Star programme, a voluntary labelling system designed to differentiate and promote energy-efficient computers, monitors and other equipment; thereby helping organisations save money and lower greenhouse gas emissions (Klopper & Meyer, 2020). On the other hand, Green ICT, also known as GICT, is the practice of managing, designing, disposing of and using information and communication technology to enhance environmental sustainability. GICT incorporates actions intended to mitigate the harmful environmental impacts of ICT while enhancing its positive contributions (Verdecchia et al., 2017). GICT means lessening the negative effect of ICT on the environment and climate change by reducing ICT's energy utilisation and CO2 emissions (Zafar et al., 2022). The subject of GICT concentrates on greening ICT by optimising the energy footprint that ICT processes cause (Hankel et al., 2019). ICT's role in driving sustainability and long-term economic goals is dependent on GICT (Zafar et al., 2022). GICT is a technology that can assist in reducing the negative emissions from information centres and its aim is to use cleaner technologies for a greener world (Anthony et al., 2018).

The summary of the above definitions of GICT focuses on optimising the use and design of ICT to improve environmental sustainability. By increasing energy efficiency, lowering carbon emissions, controlling electronic waste and supporting renewable resources, it seeks to reduce the environmental impact of ICT. The goal of GICT is to enhance environmental sustainability through better energy efficiency, reduced emissions, e-waste management and support for renewable resources. This aligns with the research objective to investigate the challenges and barriers that impact Organisation A's transition to GICT, which is essential for orchestrating an effective strategy for ecological improvement within the ICT sector.

### 2.4.2 Benefits of Green ICT

Lutkevich and McLaughlin (2023) state that GICT contributes to environmental sustainability by reducing emissions and waste, encouraging a circular economy (CE), extending device longevity, enabling cost savings, fostering an ethical corporate culture, encouraging eco-friendly product design, enhancing brand reputation and boosting customer satisfaction and loyalty. Sargam and Gupta (2022) support this view, stating that integrating green practices into organisational strategies can help organisations reduce energy consumption and

greenhouse gas emissions for a competitive edge while also prompting IT vendors to innovate solutions aimed at reducing the energy use of electronic devices.

Figure 2.5 illustrates the benefits of GICT, which include lowered emissions, waste reduction, longer maintenance cycles, cost savings, heightened awareness, a more sustainable corporate culture, environmentally friendly product design, an enhanced reputation and increased customer satisfaction and loyalty.


**Figure 2.5:** Benefits of Green ICT

**Source:** Lutkevich & McLaughlin (2023)

Hatzivasilis et al.'s (2019) study highlights that climate change poses a significant risk to environmental movements and sustainability, leading several countries to resort to green innovation; a practise that has been gaining traction in recent years to address this problem. Hankel et al. (2019) posit that ICT serves as a solution to lessen the detrimental environmental impacts of various activities, while GICT specifically targets and reduces the negative effects that ICT itself imposes on the environment. With the International Energy Agency attributing around 80% of global CO2 emissions to energy use, GICT offers an important solution to decrease both energy consumption and greenhouse gas emissions, addressing a major contributor to global warming (Islam et al., 2020). In order for organisations and nations to achieve the 2030 Sustainable Development Goals (SDGs) targets, GICT is crucial. As accelerators for sustainable development, ICTs are vital for accomplishing all SDGs and since the 2000s, GICT initiatives have been working towards a low-carbon economy while reducing technology's adverse environmental effects (N'dri et al., 2021).

In transitioning towards a net-zero world, Organisation A stands to gain significant benefits as this shift in the business landscape unveils fresh opportunities for capturing new markets and investments (TFCD Report, 2022). Gati, Salem, Serrano, Marquet, Masson, Rivera, Phan-Huy, Altman, Landre, Simon & Rouzic's (2019) study underscores the strategic significance of a comprehensive and practical green strategy for ICT; not only as a requirement for the environment but also as a means to offer an industry a competitive advantage. Organisation A can improve its market valuation by meeting evolving investor expectations on climate change and environmental, social and governance (ESG) performance; securing better access to capital through commendable sustainability actions, increasing consumer appeal, achieving net-zero targets via improved energy efficiency and product quality and finally reducing costs via sustainable procurement practises (TFCD Report, 2022). Although the aim and research objectives of this study revolves around the challenges and barriers to the transition to GICT, it is equally important to identify the benefits of GICT. Thus, this study will contribute to enabling Organisation A and SA to harness the benefits of embracing Green ICT by addressing the challenges associated with the transition.

#### *2.4.2.1 Financial motivations*

Utilising energy-efficient technology can result in a decrease in energy being used, which reduces an organisation's energy costs and carbon footprint (Lutkevich & McLaughlin, 2023). Organisation A identifies that GICT initiatives can lead to significant reductions in operational costs and provides access to favourable financing due to sustainable energy implementation and achieving high ESG ratings (TFCD Report, 2023). According to a research study conducted in Iraq, the adoption of GICT in organisations is primarily driven by cost, which has 77% importance and 70% influence (Thabit et al., 2021). Hasan, Nekmahnud, Yajuan and Patwary's (2019) study found that financial incentives, such as cost minimisation through the removal of carbon-emitting technologies and tapping into diversified opportunities, are significant drivers for the adoption of GICT. A study conducted in Brazil found that the main motivator for adopting GICT practices was the potential for cost reduction (Theis & Schreiber, 2020). Li, Zhu, Gaun and Kang's (2022) study identify the global push towards shared innovation in GICT as a potential avenue for mutual financial benefits and cost efficiencies. This review of the financial motivations was found to be important because it is seen as a significant driver for the adoption of GICT in Organisation A.

#### *2.4.2.2 Strategic and operational excellence*

Organisation A recognises the strategic edge in GICT practices, using cleaner energy sources and integrating IoT, to enhance resilience against environmental challenges and streamline operations (TFCD Report, 2022). According to a study conducted in Iraq, new market opportunities have a significant impact on the adoption of GICT in organisations, with 80% importance and 65% influence (Thabit et al., 2021). Key factors driving GICT are operational effectiveness and strategic alignment, particularly the incorporation of eco-friendly supply chain practises and socio-environmental policies (Hasan et al., 2019). According to a study done in Brazil, organisations that use GICT strategies see a noticeable improvement in operational performance (Theis & Schreiber, 2020). Li et al.'s (2022) study highlights how developed nations such as the United States, Germany and Britain have been at the forefront of GICT innovation and how structured collaborative networks have emerged to improve operational efficiency in the field. Organisation A places significant importance on strategic and operational excellence, which serves as a key driver for the organisation, focusing on enhancing sustainability to strengthen resilience against environmental challenges and optimise operational efficiency.

#### *2.4.2.3 Regulation, risk and compliance*

Organisation A places a high priority on GICT in order to actively support government climate objectives, ensure regulatory compliance and reduce potential business risks (TFCD Report, 2022). A study conducted in Iraq demonstrated that both government legislation, with 38% importance and 30% influence, and political and social pressures, with 42% importance and 45% influence, significantly impact the adoption of GICT in organisations (Thabit et al., 2021). Hasan et al. (2019) underscored the increasing importance of environmental protection regulations, risk management and compliance adherence as driving forces behind the shift towards GICT. A Brazilian study indicates that organisations are implementing GICT mainly to comply with regulations and reduce the risk of non-compliance (Theis & Schreiber, 2020). Li et al.'s (2022) study highlights the impetus provided by the global climate crisis as a factor driving countries towards innovation in the GICT space, which might lead to an evolving regulatory landscape. Organisation A prioritises GICT to align with government climate goals

and ensure regulatory compliance; recognising that regulation, risk and compliance are key drivers for the organisation.

#### *2.4.2.4 Organisational identity, culture and talent*

By adopting GICT, Organisation A will enhance its reputation as a forward-thinking organisation, attracting top talent and highlighting an innovative and responsible culture. (TFCD Report, 2022). GICT enhances corporate culture by showing employees they're part of an ethical company, increasing morale and retention, while also offering more efficient work methods through sustainable technology (Lutkevich & McLaughlin, 2023). Using green technology improves an organisation's image among the general public, strengthening its brand (Lutkevich & McLaughlin, 2023). A study conducted in Iraq revealed that organisations' adoption of GICT is influenced by enlightened self-interest, which accounts for 61% of importance and 62% of influence (Thabit et al., 2021). An organisation's decision to adopt GICT is greatly aided by a green identity shift, a sustainable culture and the recruitment of talent with similar values (Hasan et al., 2019). According to a Brazilian study, businesses are incorporating GICT policies to mould their organisational cultures and take on an identity that aligns with contemporary environmental values (Theis & Schreiber, 2020). Countries with similar social values are more likely to collaborate in GICT and a nation's inherent innovation capability significantly influences its position in the global GICT landscape (Li et al., 2022). Organisation A's strategy is strengthened by adopting GICT, which emphasises organisational identity, culture and talent as key drivers.

#### *2.4.2.5 Stakeholder engagement and partnership*

Organisations that prioritise sustainability and demonstrate their social responsibility in their strategies will see an increase in customer satisfaction and loyalty (Lutkevich & McLaughlin, 2023). The drive for more sustainable ICT practises is largely driven by the creation of partnerships with a focus on the environment and effective stakeholder engagement. (Hasan et al., 2019). Organisation A leverages GICT to foster collaboration with industry stakeholders, promote renewable energy initiatives and build sustainable business partnerships (TFCD Report, 2022). According to a Brazilian study, companies adjust their GICT practises in response to demands and expectations from stakeholders (Theis & Schreiber, 2020). Countries

that have reached similar technological milestones are more likely to form partnerships; suggesting that technological prowess is the foundation for stakeholder alignment (Li et al., 2022). The changing business landscape in a net-zero world offers Organisation A new opportunities to capture markets and investments, impacting consumer attractiveness and facilitating the achievement of net-zero targets through enhanced energy efficiency and enabling qualities of its products and services (TFCD Report, 2023). As a public company, Organisation A values stakeholder engagement and partnerships as key drivers to maintain transparency, align with shareholder expectations and secure support for sustainability efforts. These collaborations are crucial in helping Organisation A navigate market pressures and societal demands effectively, positioning it for long-term success in a competitive landscape.

#### *2.4.2.6 Sustainability, global dynamics and social responsibility*

It is imperative that carbon emissions be reduced by 7.6% annually until 2030; implementing GICT strategies promotes equipment recycling, reduces waste, strengthens the circular economy via product-as-a-service models and drives the creation of environmentally friendly technologies (Lutkevich & McLaughlin, 2023). According to an Iraqi study, businesses' obligations to the environment had a 71% importance and 77% influence on the adoption of GICT in organisations (Thabit et al., 2021). The imperative of social responsibility, the dynamics of global green movements and the global call for sustainability are the main forces behind businesses' shift to GICT (Hasan et al., 2019). According to a Brazilian study, organisations now recognise the importance of Green Information Technology (IT) in attaining more comprehensive sustainability goals and conducting ethical international business (Theis & Schreiber, 2020). The level of maturity of a country's ICT infrastructure can serve as an indicator of its commitment to sustainable digital development (Li et al., 2022). Through GICT, Organisation A emphasises its commitment to global climate discussions, sustainable innovations and its dedication to creating a lasting positive impact on the environment for future generations (TFCD Report, 2022). Corporate sustainability drives Organisation A's commitment to sustainability, global climate discussions and social responsibility through GICT.

### 2.4.3 Challenges and barriers to Green ICT

To address the primary objective of identifying the barriers facing a SA telecommunication organisation in transitioning to Green ICT and the secondary research objective of investigating the challenges and barriers that impact Organisation A's transition to Green ICT, the literature review highlighted the most common challenges and barriers, revealing previously documented issues in the field, as illustrated below.

#### *2.4.3.1 Challenges to Green ICT*

Challenges are those situations that one must overcome with significant effort in order to prevail (Batra, 2021). An assignment, responsibility or circumstance that demands a great deal of skill, perseverance and effort in order to succeed (Cambridge University Press & Assessment, 2023). Challenges are tough circumstances that call for a lot of skill, perseverance and effort to successfully navigate. When properly addressed, they frequently require a great deal of dedication and can promote both professional and personal growth. Four challenges to Green ICT are discussed, namely, cultural and social challenges, knowledge and communication challenges, market and demand challenges and readiness challenges as outlined below in Table 2.1.

**Table 2.1: Primary challenges to Green ICT**

| Challenges to Green ICT | Description |
|---|---|
| Cultural and social challenges | • A study conducted in the Netherlands found that cultural norms and beliefs are not supportive of ICT and sustainability, which creates challenges for the adoption of GICT (Hankel et al., 2019).<br>• A study in Brazil indicates that for the proactive implementation of GICT, organisations within the country must undergo a cultural change, embracing and embedding values, beliefs and practices of environmental sustainability that impact behaviour at both the organisational and individual levels (Theis & Schreiber, 2020).<br>• Cultural challenges occur when individuals find it difficult to adjust to a CE due to ingrained customs and beliefs, which are made worse when they don't comprehend or accept the CE's importance and benefits (Grafström & Aasma, 2021).<br>• The transition to a circular economy is hindered by societal and cultural challenges, particularly evident in older populations, less educated individuals and higher income groups; leading to a decreased engagement in recycling and sustainable consumption practices, reflecting deep-rooted habits, limited awareness and prevailing values that prioritise newness and consumption over environmental sustainability (Neves & Marques, 2022). |

| Challenges to Green ICT | Description |
|---|---|
| | • The rapid rise in devices per capita and the growing number of internet users emphasise the need for a shift in the public mindset and behaviours for successful GICT implementation (Radu, 2018).<br>• It appears that a large number of the challenges are people-dependent, indicating that altering organisational cultures and attitudes will be challenging (Ara, 2018). |
| Knowledge and communication challenges | • In the Netherlands, there's a deficiency in understanding and communicating GICT solutions (Hankel et al., 2019).<br>• A study conducted in Bangladesh reveals that there is a critical lack of qualified professionals to implement GICT; the study also highlights a significant knowledge gap in this area (Ara, 2018).<br>• Creating and sharing best practices is significantly hampered by the glaring gap in cooperative innovation research in the field of GICT (Li et al., 2022).<br>• A study in Brazil has highlighted a significant knowledge gap regarding GICT and its benefits to society, stemming from a lack of extensive research in this area (Theis & Schreiber, 2020).<br>• There is a gap in disseminating knowledge about the CE concept, coupled with challenges in effectively communicating its benefits and the importance of transitioning to it (Grafström & Aasma, 2021).<br>• A study in Romania points out that, despite the sophistication of the ICT sector, a substantial disconnect between the educational system and the demands of the labour market has led to a scarcity of qualified professionals; which in turn obstructs the advancement and deployment of GICT (Radu, 2018).<br>• There is a deficiency in knowledge regarding GICT and the potential advantages it can offer organisations (Gotay & Ist, 2020).<br>• Organisations generally lack commitment and awareness regarding sustainable practices as evidenced by their lack of enthusiasm for leading green or sustainable ICT workshops and their frequent inexperience with the power usage details of the technology they purchase (Ara, 2018). |
| Market and demand challenges | • According to a Bangladesh study, the adoption of GICT initiatives faces challenges due to consumer demand and the strategic approaches taken towards these initiatives (Ara, 2018).<br>• The USA and other traditional technological powers' dominant position in the GICT cooperation network may make it more difficult for other countries, such as China, Germany, the UK and India, to influence the network's priorities and direction (Li et al., 2022).<br>• A Brazilian study notes that organisations in Brazil place insufficient focus on utilising GICT as a strategy to improve their market standing or to shape public opinion (Theis & Schreiber, 2020).<br>• The decreased demand for recycled materials has created obstacles to market (Grafström & Aasma, 2021). |
| Readiness challenges | • In India, telecommunications organisations need to address their technology readiness, financial readiness and organisational readiness to prepare for enhanced adoption of GICT (Sargam & Gupta, 2022). |

| Challenges to Green ICT | Description |
|---|---|
| | • As GICT becomes a cutting-edge and highly complex field of technology, countries must make sure they are ready to close technological gaps, enhance technological proximity and modernise traditional ICT infrastructures (Li et al., 2022).<br>• The lack of readiness and preparation that organisations and governments face when implementing a CE raises concerns about where to begin and how to ensure an effortless transition (Grafström & Aasma, 2021).<br>• Radu's (2018) study has shown progress in Romania's ICT sector but its readiness to handle GICT challenges, especially concerning e-waste, remains a concern. |

**Source:** Author's compilation (2024)

#### *2.4.3.2 Barriers to Green ICT*

Barriers refer to the obstacles that prevent or obstruct functioning in whole or in part (Batra, 2021). Something that complicates or stops something else from happening (Cambridge University Press & Assessment, 2023a). Barriers are impediments that hinder or prevent certain actions or outcomes, making tasks more difficult to complete. Five barriers to Green ICT, namely, organisational and strategic barriers, technical and infrastructure barriers, financial barriers, policy and regulatory barriers and external and physical barriers are outlined below in Table 2.2.

**Table 2.2: Primary barriers to Green ICT**

| Barriers to Green ICT | Description |
|---|---|
| Organisational and strategic barriers | • Hankel et al.'s (2019) study has shown that the lack of leadership commitment, the lack of alignment between all management layers and strategic objectives and limited ownership and governance of GICT have been noted as obstacles in the Netherlands.<br>• Comprehensive understanding and full participation of other countries in GICT innovation are restricted by the absence of research on cooperative innovation in the field and the dominance of core countries such as the USA (Li et al., 2022).<br>• In Brazil, IT companies have a reactive approach to GICT, lack strategic objectives for its implementation and the study mainly involved smaller service providers (Theis & Schreiber, 2020).<br>• Organisational structures are often inefficient and do not support a CE transition; compounded by a lack of centralised management that prioritises CE objectives and goals (Grafström & Aasma, 2021). |

| Barriers to Green ICT | Description |
|---|---|
| | • Developed countries possess a significant technological advantage over developing nations, which makes it more difficult for the latter to implement comprehensive growth strategies (Murshed, 2020).<br>• A lack of corporate support for making green information technologies a priority (Gotay & Ist, 2020).<br>• Dawadi et al.'s (2020) study in Nepal has identified a critical shortage of skilled workers in the ICT sector that is obstructing technological progress and the ability to maintain sophisticated ICT systems. |
| Technical and infrastructure barriers | • A study conducted in the Netherlands found that among the country's challenges are problems with the technical infrastructure that could prevent the adoption of GICT (Hankel et al., 2019).<br>• Additionally, in Bangladesh, the accessibility of GICT equipment presents barriers (Ara, 2018).<br>• Despite increasing participation, the GICT cooperation network's size remains small, indicating challenges in expanding the network's reach and effectiveness (Li et al., 2022).<br>• The transition to a CE is hampered by the lack of scalable solutions and the complexities involved in updating existing systems (Grafström & Aasma, 2021).<br>• Murshed's (2020) study emphasises that achieving energy security and environmental sustainability is significantly hampered by a lack of technological efficiency.<br>• Leskaj and Lazimi's (2023) study has shown that despite its importance, Albania's telecommunications sector struggles with challenges such as low density, outdated technology and poor service quality; exacerbated by less infrastructure investment than in other countries.<br>• The desire to electrify non-electrical equipment and the ownership of multiple devices are the main causes of the rise in e-waste (Radu, 2018).<br>• A noticeable lack of reliable sources of recycled materials (Grafström & Aasma, 2021).<br>• Dawadi et al.'s (2020) study has shown ICT development in Nepal is hindered by a lack of support for essential applications and protocols as well as significant security issues that prevent the development of a reliable and secure ICT infrastructure (Leskaj & Lazimi, 2023). |
| Financial barriers | • Zafar et al.'s (2020) study across 16 Asian countries has pointed out the lack of funding for green infrastructure like wind, solar, geothermal and bioenergy sources.<br>• Similarly, in Bangladesh, there is a noted lack of policy funding (Ara, 2018). |

| Barriers to Green ICT | Description |
|---|---|
| | • A key barrier is the high cost of investment as industries grapple with the financial effects of implementing new technologies (Grafström & Aasma, 2021).<br>• Lack of investment in green finance and sustainable business models, which are necessary for environmental protection and adherence to circular economy principles, is impeding the supply side of the circular economy (Neves & Marques, 2022).<br>• The economy is primarily reliant on non-renewable energy (NRE) sources; wit insufficient measures or incentives in place to encourage transitioning to renewable energy (RE) from NRE (Murshed, 2020).<br>• Radu's (2018) study found the lack of investment in research and development in Romania, with expenditure considerably lower than the EU average, discourages interest in innovation among its citizens.<br>• It is expensive to upgrade current ICT systems or install new infrastructure due to high migration costs, which makes it difficult for Nepal to stay up to date with technological advancements (Dawadi et al., 2020). |
| Policy and regulatory barriers | • A study conducted across 16 Asian countries found an inadequate policy focus on fossil fuel usage was a significant barrier (Zafar et al., 2022).<br>• A study conducted in India found regulatory readiness presents barriers for GICT adoption (Sargam & Gupta, 2022).<br>• The diminishing significance of institutional distances in GICT cooperation over time suggests that countries with distinct institutional structures might find it difficult to participate effectively (Li et al., 2022).<br>• Institutional barriers, regulatory constraints that favour linear products over CE products and the lack of property rights, price signals and subsidies hinder the transition to a circular economy (Grafström & Aasma, 2021).<br>• According to a study, current foreign investment regulations discourage direct investments in the ICT sectors of South Asian economies, while trade barriers limit the flow of ICT goods and services across borders (Murshed, 2020).<br>• Radu's (2018) study showed that Romania struggles with the practical application of GICT directives, despite being required as an EU member to adopt them; between 2007 and 2016, over 70% of waste was disposed of in landfills.<br>• One major barrier is the lack of stringent regulations from the government since, without them, organisations may not have the incentive or direction to adopt GICT (Ara, 2018).<br>• The economic impact of the telecommunications industry has been hampered by inadequate policy and a lack of competition, indicating the need for government initiatives to encourage investment and uphold competition, with a focus on expanding broadband access in rural areas (Leskaj & Lazimi, 2023). |

| Barriers to Green ICT | Description |
|---|---|
| | • Dawadi et al.'s (2020) study identified a pressing need for the Nepalese government to align ICT and broadband policies with energy policies, which is crucial for greening the national network infrastructure in an eco-friendly manner. |
| External and physical barriers | • Organisation A mentioned barriers to adopting on-site renewable energy due to space limitations and theft concerns (Sustainability Report, 2022).<br>• Li et al.'s (2022) study found that influence mechanisms of the network vary across different climate change scenarios and ICT development levels, implying potential adaptability barriers for countries.<br>• Physical barriers such as ineffective supply chains for recycled materials are combined with external pressures from traditional industries that are resistant to change (Grafström & Aasma, 2021).<br>• The growing amount of e-waste, resulting from shorter replacement cycles and multi-device ownership, has made recycling procedures more difficult and important (Radu, 2018).<br>• Barriers to GICT include operators' power assurance and data centre site selection and, although artificial intelligence assists with environmental monitoring, it also poses security risks (Popli et al., 2021).<br>• The challenging diverse geography of Nepal makes it difficult to build the physical infrastructure required for ICT across the country (Dawadi et al., 2020). |

**Source:** Author's compilation (2024)

The analysis of challenges and barriers to Green ICT within the telecommunications sector is integral to achieving the primary objective of this study: identifying the principal challenges that a South African telecommunication organisation, Organisation A, encounters during its transition to Green ICT. The insights gained from this exploration are pivotal for developing effective strategies that promote a successful and environmentally responsible implementation of Green ICT initiatives within the organisation. Furthermore, these insights are instrumental in formulating the research questions that drive this study. This approach not only shapes the research direction but also ensures that the questions are meticulously designed to uncover and address the fundamental obstacles hindering the adoption of sustainable ICT practices within Organisation A.

### 2.4.4 Green ICT practices and technologies

Airehrour et al. (2019) state that GICT initiatives have quickly increased, allowing GICT to potentially address the demands of today's generation, without compromising the prospects of future generations, by utilising environmentally friendly devices that reduce carbon emissions. Integrating green practices into business strategies can help organisations reduce energy consumption and greenhouse gas emissions and gain a competitive edge, while IT vendors simultaneously strive for innovative solutions to address the energy consumption of electronic devices (Sargam & Gupta, 2022). At both national and international levels several strategies and policies have been developed; with governments and policymakers playing a crucial role in funding programmes and initiatives by organisations focused on environmentally conscious methods, such as lowering greenhouse gas emissions and conserving energy (Airehrour et al., 2019). The following shows prevalent GICT practices and technologies identified in academic research.

#### *2.4.4.1 Energy efficiency*

Enhancing energy efficiency entails concentrating on more effective energy use to reduce waste and lowering the energy consumption of IT equipment by reducing the hardware requirements (Salles, Lunardi & Thompson, 2022). Energy-efficient hardware design is essential for developing devices and equipment that achieve optimal performance with minimal power consumption, ensuring low energy usage without compromising functionality or efficiency (Albreem, Sheikh, Alsharif, Jusoh & Mohd Yasin, 2021). Behavioural change models intend to raise awareness about energy conservation among IoT users and service providers (Albreem et al., 2021). Smart appliances optimise energy use and storage, electrified cars and ICT optimise routing to reduce energy consumption and cutting-edge ICT enhances power grid operations for astute energy distribution management (Aldakhil et al., 2019). The energy sector can benefit from the accessibility of finance to innovate and implement energy-efficient solutions (Tang, Xu, Hao, Wu & Xue, 2021). ICT infrastructures can become more energy efficient by incorporating clean energy sources (Zhang, Khan, Dagar, Saeed & Zafar, 2022).

GICT organisations are transforming energy from a mere consumable item to a service; enabling efficient and effective energy management (Jnr, Majid & Romli, 2018). Green information technology systems help in optimising processes to attain this balance, making organisations more efficient in their operations while lowering their carbon footprint (Imasiku

et al., 2019). Data centres are implementing efficient cooling systems, utilising dynamic server provisioning and adaptive power strategies to reduce electricity usage, integrating AI for optimised energy consumption and developing IoT devices with energy harvesting capabilities to self-generate power, thus boosting the energy efficiency of ICT ecosystems (Popli et al., 2021). NTT Data's global delivery centre in India, in partnership with PhonePe, has adopted liquid immersion cooling (LIC) technology for their servers, enabling the use of high-end servers with improved cooling efficiency and reduced environmental impact (NTT Data, 2023a). Pambudi, Sarifudin, Firdaus, Ulfa, Gandidi and Romadhon's (2022) study highlighted immersion cooling technology as a significant advancement in efficient energy management, applied across various sectors like photovoltaic cells, data servers and electric vehicles, and marked by its historical development and superiority over traditional cooling methods. (Pambudi et al., 2022). The Bellas Vistas power plant in Madrid successfully implemented an immersion liquid cooling system, cutting non-IT energy use by 75% and removing refrigerant gas; thereby enhancing server cooling efficiency to support expanding needs in edge computing and 5G (Telefónica, 2022). Software-based data traffic management plays a crucial role in improving energy efficiency by optimising the handling and routing of data traffic, significantly reducing energy consumption associated with data communication (Albreem et al., 2021).

#### *2.4.4.2 Sustainable design and production*

By replacing outdated equipment with modern, energy-efficient technologies and investing in clean, sustainable solutions, we can enhance the efficiency and agility of IT resources (Theis & Schreiber, 2020). It is imperative to prioritise the creation of ecologically sustainable IoT applications in addition to creating systems that meet stringent power budget constraints (Albreem et al., 2021). Green business practices involve incorporating sustainable materials and minimising waste in production and manufacturing processes; embedding sustainability into organisational culture through the Green Organisational Movement; and highlighting the 3R Manufacturing Process by emphasising Reduce, Reuse and Recycle in design and production (Hasan et al., 2019). Aligning IT products and services with sustainability is essential; incorporating sustainable approaches in both corporate strategy and IT projects, processes and strategies (Salles, Lunardi & Thompson, 2022).

Promoting sustainable design principles in businesses by utilising digital technologies to improve the sustainability of traditional production methods (Tang et al., 2021). Encouraging sustainable agricultural mechanisation and eco-design, coupled with implementing ICT for socio-economic sustainability, promotes environmentally friendly design and production methods (Aldakhil et al., 2019). Organisations are trying to create more environmentally friendly business processes by redesigning or creating new ones (Jnr et al., 2018). Gati et al.'s (2019) study highlights several technological innovations and approaches to advance green networking: it suggests transitioning to massively parallel communications; adopting gallium-based semiconductors for enhanced telecom performance under high voltage and frequency; leveraging optical technologies such as fibre to the home (FTTH) for access networks and optical routing for core networks to cut energy use and emphasising the development of green wireless networks that focus on hardware efficiency, massively parallel antennas, energy-free communication tags and implementing a universal green operating system. The development of sustainable IoT infrastructure is being advanced through the design and deployment of self-powered or battery-free IoT devices, sensors and actuators, alongside the creation of 5G green physical layer solutions such as NB-IoT, which cater to large-scale IoT applications with minimal power requirements (Popli et al., 2021). The design and production of products with minimal negative environmental impacts reduces the need for new raw materials and decreases the strain on natural ecosystems (Velenturf & Purnell, 2021). Developing resilient and cutting-edge ICT infrastructures encourages sustainable design (Zhang et al., 2022).

#### *2.4.4.3 E-waste management*

As electronic waste has become a major concern, the circular economy seeks to manage and reduce e-waste through recycling, repurposing and minimising the production of harmful waste (Velenturf & Purnell, 2021). To minimise waste and its associated costs, it's essential to reduce disposal while also promoting recycling and the incorporation of recycled components in IT (Salles et al., 2022). Efforts to mitigate electronic waste are being implemented by extending the battery life of IoT devices (Popli et al., 2021). Encouraging a recycling culture is crucial to supporting e-waste mitigation and putting recycling policies into practice is necessary to address the issues surrounding electronic waste (Albreem et al., 2021). Ensuring electronic waste is disposed of correctly, through specialised companies, is essential and repurposing computers, no longer beneficial to organisations, for philanthropic efforts further promotes sustainability and goodwill (Theis & Schreiber, 2020). Hasan et al.'s (2019) study presents an

environmentally conscious approach to product design and waste management, focusing on minimising waste and optimising recycling and reuse throughout the product's lifecycle.

#### *2.4.4.4 Renewable energy*

The adoption of green technologies, which are essential for protecting the environment, can contribute to the United Nations' "green is clean" goal by replacing conventional energy resources with renewables to lower carbon emissions (Batool, Sharif, Islam, Zaman, Shoukry, Sharkawy, Gani, Aamir & Hishan, 2019). Many researchers propose an intuitive approach, which includes utilising renewable energy sources such as solar, wind and tidal power to offset the carbon footprint of ICT (Leung, Dong & Pan, 2021). Telecommunications towers have historically relied on conventional power sources like the grid, batteries and diesel generators but, with the aim of enhancing reliability, alternative options such as photovoltaic panels, wind turbines and fuel cells have been investigated, and hybridisation of conventional and renewable energy systems has also been deliberated (Deevela et al., 2023). To improve sustainability, ICT infrastructures are incorporating renewable energy and implementing energy harvesting in user devices and sensors (Popli et al., 2021). Investing in renewable energy-centric ICT can mitigate greenhouse gas emissions and lower energy costs through the adoption of smart grid technologies, despite the ecological footprint that the technology itself carries, which must be managed with appropriate environmental measures (Aldakhil et al., 2019). By integrating and utilising power from renewable energy generators, data centres in wireless sensor networks can significantly reduce energy costs and carbon footprints due to their flexible workload capacities (Albreem et al., 2021). The adoption of energy-saving techniques across various sectors and the wider implementation of renewable energy technologies should be taken into consideration concurrently with the deployment of ICT services (Zhang et al., 2022).

#### *2.4.4.5 Virtualisation and cloud computing*

Virtualisation and cloud computing are parts of the informatisation enhancement; reducing the physical IT resources needed and promoting efficiency (Tang et al., 2021). Fog/Edge computing extends cloud services to network edges to decrease latency, while cloud and fog computing process data efficiently to minimise energy use (Albreem et al., 2021). Organisations can practice GICT, leading to cost savings, by adopting initiatives such as information virtualisation and technologies for database virtualisation (Theis & Schreiber,

2020). Dynamic virtual machine (VM) consolidation for energy efficiency and the evolution of centralised and wireless networks toward virtualised architectures are key trends, with emerging next-generation points of presence (NGPoPs) hosting virtualised content delivery networks (CDNs) to streamline content delivery and reduce core network traffic (Gati et al., 2019). Energy-efficient data centres are crucial in the domain of data storage and processing as they optimise power utilisation to process, store and manage data; thereby reducing energy costs and minimising the environmental impact of these facilities (Albreem et al., 2021). Virtualisation is being used at the storage, network and server levels in an effort to lessen electronic waste due to the fact that it eliminates the need for physical devices (Popli et al., 2021).

#### *2.4.4.6 Remote work*

Improving ICT in rural areas can support telecommuting and remote work, reducing the need for transportation and thereby decreasing CO2 emissions (Zhang et al., 2022). Sutton-Parker's (2021) study identified that leveraging IT for remote work offers an immediate and significant reduction in GHG emissions, a practice that, if adopted globally alongside sustainable transportation, could contribute substantially towards meeting the UN's emissions reduction goals by 2050. Productivity and collaboration tools enable remote work and connections both within and outside organisations, leading to significant environmental benefits through decreased travel and fuel use and the reduced need for office heating, ventilation and air conditioning; ultimately lowering CO2 emissions and causing less urban pollution (Telefónica, 2022). Online conferencing services facilitate interactive, location-independent collaboration globally, reducing business travel and commuting, saving time and significantly cutting CO2 emissions (Swisscom, 2022). Adopting ICT applications for virtual meetings and teleconferencing to reduce travel and associated carbon emissions (Aldakhil et al., 2019). Wu, Chang and Chen's (2024) study highlights the potential environmental benefits of work from home or hybrid work setups but also stresses the need for tailored decarbonisation strategies for different demographic groups.

#### *2.4.4.7 Network efficiency*

In pursuit of progressing GICTs, researchers are employing a range of cutting-edge methodologies, such as advanced communication techniques, control theory, machine learning,

quantum computing and game theory, with the expectation that integrating these powerful tools will optimise resource utilisation efficiency in the future (Leung et al., 2021). Gati et al.'s (2019) study emphasises that using mathematical models and tools is vital for effective energy management and the optimisation of network operations. Integrating artificial intelligence (AI) and machine learning (ML) into the green internet of things (GIoT) enhances energy efficiency in IoT networks, while data prediction and compression techniques further reduce energy consumption (Albreem et al., 2021).

Modern information systems in various sectors ensure network efficiency, decreasing energy consumption (Zhang et al., 2022). Optimising energy consumption through intelligent content placement within networks, streamlining network architectures, switching from conventional to sophisticated central offices and developing a global green operating system for increased energy and spectral efficiency (Gati et al., 2019). Access networks are being densified to boost spectrum efficiency, cell shaping methods like cell breathing and traffic-based cell activation are in use, aerial base stations employing unmanned aerial vehicles (UAVs) are being deployed to conserve energy and narrowband internet of things (NB-IoT) is evolving towards more energy-efficient releases (Popli et al., 2021). Better telecommunications infrastructure can lead to improved network efficiency as part of corporate sustainability practice (Tang et al., 2021).

Significant increases in network efficiency are required for both integrating ICT into transportation systems and optimising the power grid to improve network efficiency within power distribution systems (Aldakhil et al., 2019). Dawadi et al.'s (2020) study examines ICT deployment in Nepal, particularly focusing on green networking with software defined IPv6 (SoDIP6), highlighting its potential to significantly reduce energy use and carbon emissions within a typical ISP's access networks; thereby promoting a sustainable ICT environment. By decentralising the consumption of IoT networks, distributed databases in blockchain technology has lower energy consumption (Albreem et al., 2021). Switching to massively parallel communications from point-to-point and using optics to lower energy consumption in ICT networks (Gati, Salem, Serrano, Marquet, Masson, Rivera, Phan-Huy, Altman, Landre, Simon & Rouzic, 2019). The development of comprehensive energy models for IoT devices, which consider all significant factors affecting power usage, is crucial for ensuring energy-efficient operation. Given the increasing ubiquity and potential high energy consumption of these devices it is complemented by the implementation of power consumption reduction

strategies in IoT network design to optimise energy efficiency across all network components (Albreem et al., 2021).

#### *2.4.4.8 Green standards and policies*

Improved corporate governance encourages adherence to green standards and policies; while equalising digital network resources aligns with green standards for accessibility and efficiency (Tang et al., 2021). The triple bottom line approach is incorporated into the integration of social, environmental and economic policies and the green organisational movement makes sure that an organisation's strategies and values are in line with green standards (Hasan et al., 2019). In order to facilitate the shift to a sustainable circular economy, governments must develop and implement green standards and regulations that force industries to phase out unsustainable practices (Velenturf & Purnell, 2021). Raihan's (2023) study proposes that Malaysian policymakers create an environmental strategy that utilises ICT to cut emissions and simultaneously promote economic expansion. Aligning tech policies with environmental aims promotes eco-friendly innovation, while implementing tariffs counters harmful technologies and proactively addressing future ICT evolution ensures adherence to green standards (Zhang et al., 2022). Introducing Green as a vital KPI (Key Performance Indicator) for networks and collaborating with suppliers and industrial ecosystems for green developments (Gati et al., 2019). Green standards and policies can be established through the creation and application of ICT-driven e-sustainability policies as well as the use of ICT tools for governance (Aldakhil et al., 2019).

Dawadi et al.'s (2020) study has shown that Nepal's telecommunications authority funds improvements in rural ICT services through a royalty from ISPs and telecom operators; with the rural telecommunications disbursement fund expected to foster societal and economic advancements in these areas. Raihan's (2023) study emphasises "greening through ICT"; calling on the Malaysian government to enact policies that promote the adoption of eco-friendly ICT products and services and to stimulate foreign direct investment in advanced, sustainable ICT technologies. Through its alignment with the SDGs, green information technology systems (ITS) play a pivotal role in safeguarding the environment and furthering the advancement of green economic development (Imasiku et al., 2019). Developing systems are being implemented to disseminate information and foster awareness about sustainable practices aligned with the United Nations' sustainable development goals, concurrently encouraging

innovation within the ICT sector to diminish its carbon emissions (Batool et al., 2019). Dawadi et al. (2020) stress the need for green networking practices and policy focus by governments, especially in mountainous developing nations like Nepal, due to their vulnerability to climate change and global warming's effects . The establishment of a centralised authority to oversee global carbon emission compliance, coupled with the adoption of corporate shared value (CSV) and certifications like the renewable energy certificate (REC), is essential to unify GHG reduction efforts, foster economic and societal value, standardise green practices and unveil new business prospects (Imasiku et al., 2019).

#### *2.4.4.9 Research and innovation*

Establishing a research and development-friendly environment encourages businesses to experiment and take measured chances with emerging green technologies (Tang et al., 2021). Innovative green technologies and research can improve resource productivity through the use of eco-friendly business practices (Hasan et al., 2019). Raising awareness about the confluence of education, ICT and sustainability is essential and utilising media further amplifies research findings and innovative environmental solutions (Zhang et al., 2022). Gati et al.'s (2019) study underlines the importance of creating energy-efficient software and implementing dynamic resource management within data centres to reduce energy wastage. While the maturity of IT practices is used to assess the development of IT sustainability, the socio-technical movement is innovating how organisational resources are combined for sustainability; a structured roadmap is used to provide guidance for the introduction of new GICT practices (Salles et al., 2022).

Bolstering research in sustainable development, mapping overall energy use, harmonising Green KPI and employing game theory for equitable energy consumption analysis across different entities (Gati et al., 2019). AI in IoT data analysis employs innovative techniques for more informed decision-making (Albreem et al., 2021). Innovations in mobile and edge computing are enabling efficient distribution of computation; AI is being integrated to improve efficiency in spite of potential increases in power consumption and latency; data centre waste heat is being recycled for community heating and NB-IoT and other green physical layer solutions are still being developed (Popli et al., 2021). The competition in satellite mobile broadband is escalating, with companies like Starlink and Project Kuiper leading the charge in deploying Low-Earth-Orbit (LEO) satellites to provide internet access in remote areas,

focusing on various solutions including fixed-wireless access, data backhaul, IoT connectivity, high-capacity data transport and innovative direct-to-mobile connectivity that could challenge traditional mobile operators (TechCentral, 2024).

Ongoing innovation in ICT is being encouraged for energy efficiency and environmental gains, as well as in healthcare IT to address environmental health impacts (Aldakhil et al., 2019). Gati et al.'s (2019) study emphasises the necessity of incorporating GICT strategies into educational curricula and research; underscoring the pivotal role that universities and research institutions play in advancing this green transition.

In line with the secondary objective of assessing the current state of GICT adoption within the organisation, this section provides a comprehensive overview of specific GICT practices and technologies globally. By presenting a range of effective and innovative technologies from across the globe, this section broadens the potential solutions that Organisation A might consider adopting or adapting, directly supporting the primary objective of identifying the key challenges Organisation A faces in transitioning to GICT. This global perspective is vital for pinpointing best practices that can help overcome specific challenges and barriers identified as part of the secondary objective to investigate hurdles in the organisation's GICT transition. The insights gained also make it easier to create research tools and write strategic recommendations. This meets the secondary goal of coming up with doable plans to assist Organisation A in navigating and overcoming these issues, thereby improving its ICT sustainability efforts.

### 2.4.5 Green ICT globally and in developing countries

Reviewing GICT practices globally and in developing countries is crucial to establish benchmarks with international standards and explore adaptable strategies relevant to developing countries. This approach enhances the analysis by highlighting the benefits and importance of GICT, while also offering insights into addressing local challenges and formulating strategic recommendations that align with global sustainability efforts.

The United Nations reports that the world is increasingly united in addressing CO2 emissions and pursuing sustainable development among ongoing unsustainable consumption of the earth's finite resources, which has resulted in environmental challenges including biodiversity loss, resource depletion, air pollution and climate change (Imasiku et al., 2019). Numerous countries globally have ratified the COP21 agreement, with governments being encouraged to

transition to clean, green and eco-friendly energy sources (Charfeddine & Kahia, 2021). The Paris Agreement, ratified by the European Union and 174 countries in 2016, has been both praised and criticised for its long-term objective of limiting global average temperature increases to 1.5 °C in order to mitigate the risks and effects of climate change amid rising greenhouse gas emissions (Airehrour et al., 2019).

In developed countries, many organisations have adopted GICT in their operations, but in developing countries various challenges hinder organisations from incorporating GICT (Thabit et al., 2021). Tanzania's corporate landscape exhibits innovation and a willingness to adopt eco-friendly products and solutions, yet various challenges obstruct the nation's progress in fully embracing GICT and associated strategies (Makundi, Mwendwa & Wabwoba, 2022). Thabit et al.'s (2021) findings indicate that the adoption of GICT by organisations in Iraq is affected by several factors. Ukhurebor et al.'s (2020) study found that, regardless of environmental protection policies in Nigeria, there was a lack of specific tools for managing electronic waste and data centre impacts; potentially due to unanticipated technological advancements during policy formulation.

Technological innovations are pivotal for developing countries to enhance their role in greening global value chains and transitioning to sustainable economic sectors, their success depending on the swift and concerted efforts of local governments and international entities to implement supportive policies and expand eco-friendly green technologies (UNCTAD, 2023a). Sustainable technologies provide a significant benefit for developing economies by allowing them to skip over conventional technology adoption phases—termed technological leapfrogging—enabling these countries to implement newer, more cost-effective solutions more rapidly and inexpensively without facing the entrenched system risks that advanced economies do. With policy reforms, financial accessibility and a worldwide demand for sustainability acting as major influences, these factors collectively reduce entry barriers and accelerate the assimilation of eco-friendly technologies in the developing world (UNCTAD, 2022).

UNCTAD (2023a) predicts that the 17 frontier technologies could create a $9.5 trillion US dollar market by 2030. Developed countries are currently capitalising on these opportunities, with their green technology exports surging to $156 billion in 2021, while developing nations have seen a decrease in their global export share from 48% to 33% in the same timeframe.

Frontier technologies, advancing rapidly through digitalisation and connectivity, not only bolster economic and labour market growth but also enable capable countries to explore new sectors like renewable energy and EVs; "opening green windows" for economic progress, while challenging developing economies to improve their readiness and bridge gaps in usage, adoption and adaptation of these innovations (UNCTAD, 2023a). According to the United Nations Conference on Trade and Development, the United States, Sweden, Singapore, Switzerland and the Netherlands rank as the top five countries ready to embrace and implement frontier technologies crucial for the transition to green technology (World Economic Forum, 2023). A ranking of 166 countries, based on their readiness to deploy frontier technologies, was evaluated across five key indicators: ICT, skills, industry, research and development and finance; with the final score derived from the aggregate rank of each indicator (World Economic Forum, 2023).

Figure 2.6 shows a selection of a few developed and developing countries from a classification of 166 countries based on their preparedness to adopt frontier technologies.

| | Rank in 2022 | Rank in 2021 | Movement in rank | ICT ranking | Skills ranking | R&D ranking | Industry ranking | Finance ranking |
|---|---|---|---|---|---|---|---|---|
| **Top 10** | | | | | | | | |
| United States of America | 1 | 1 | – | 11 | 18 | 2 | 16 | 2 |
| Sweden | 2 | 4 | ▲ | 6 | 2 | 16 | 11 | 18 |
| Singapore | 3 | 5 | ▲ | 7 | 8 | 17 | 4 | 17 |
| Switzerland | 4 | 2 | ▼ | 21 | 13 | 12 | 5 | 5 |
| Netherlands | 5 | 6 | ▲ | 4 | 9 | 15 | 10 | 31 |
| Republic of Korea | 6 | 7 | ▲ | 15 | 26 | 3 | 9 | 7 |
| Germany | 7 | 9 | ▲ | 24 | 17 | 5 | 12 | 40 |
| Finland | 8 | 17 | ▲ | 22 | 5 | 21 | 20 | 30 |
| China, Hong Kong SAR | 9 | 15 | ▲ | 9 | 23 | 29 | 2 | 1 |
| Belgium | 10 | 11 | ▲ | 13 | 4 | 23 | 19 | 48 |
| **Selected transition and developing economies** | | | | | | | | |
| Russian Federation | 31 | 27 | ▼ | 43 | 32 | 13 | 54 | 69 |
| China | 35 | 25 | ▼ | 117 | 92 | 1 | 8 | 4 |
| Brazil | 40 | 41 | ▲ | 50 | 55 | 18 | 51 | 57 |
| India | 46 | 43 | ▼ | 95 | 109 | 4 | 22 | 75 |
| South Africa | 56 | 54 | ▼ | 71 | 77 | 36 | 67 | 25 |

**Figure 2.6:** Index of readiness for the use of frontier technologies

**Source:** UNCTAD (2023b)

The top of the readiness index is primarily occupied by affluent countries, with the United States, Sweden, Singapore, Switzerland and the Netherlands leading the pack. Meanwhile, rising economic powers are generally positioned in the second quartile of the index, with Brazil at rank 40, China at 35, India at 46, the Russian Federation at 31 and SA at 56 (UNCTAD, 2023b). For emerging economies to harness the economic potential of new technologies, it's crucial for businesses to acquire the necessary skills and for governments to implement conducive policies and infrastructure, although nations in Latin America, the Caribbean and Sub-Saharan Africa lag behind in this readiness, facing the risk of missing technological advancements; in contrast to countries like Finland, Hong Kong SAR and China, which have notably climbed in the 2023 readiness rankings due to significant investments in human capital and the increase of highly skilled jobs (UNCTAD, 2023b).

In developing economies, policymakers often prioritise high economic growth and GDP per capita over environmental goals, even though economic growth can initially lead to increased environmental degradation, as explained by the Environmental Kuznets Curve theory which shows an inverted U-shaped relationship between economic growth and CO2 emissions suggesting that, after reaching a certain level of development, economic growth can lead to reduced emissions (N'dri et al., 2021). Aldakhil et al.'s (2019) study in South Asia confirmed the Environmental Kuznets Curve, demonstrating an inverted U-shaped correlation between carbon emissions and per capita income alongside population growth; it also endorsed the Pollution Haven Hypothesis by revealing that without environmental considerations, increased foreign direct investment and trade openness may lead to higher carbon emissions.

Technological innovations have the potential to enhance the role of developing countries in greening global value chains and fostering sustainable economic growth, especially when supported by new environmental legislation and public-private partnerships that accelerate renewable energy development (UNCTAD, 2022). China's 2006 renewable energy legislation catalysed its biomass sector; Egypt's 2014 law facilitated private government collaborations in renewable electricity and Chile, Panama and SA are progressing in the green hydrogen sector, which is in line with sustainable development objectives which positions them to capitalise on the labour gap in wealthier countries for producing electrolysers to meet the growing European, Japanese and South Korean markets for green hydrogen (UNCTAD, 2022). From 2018 to 2021,

green tech exports from developing nations grew from $57 billion to $75 billion but their global market share shrank from 48% to 33%; while developed nations boosted their green exports from $60 billion to $156 billion (UN, 2023).

The director of UNCTAD's technology and logistics division stresses the need for developing countries to adopt advanced industrial, innovation and energy policies focused on green technologies to drive sustainable economic growth and strengthen future crisis resilience (UN, 2023). Guinea, the Democratic Republic of Congo, Gambia, Guinea-Bissau, and South Sudan rank at the bottom of the list, while regions such as Latin America, the Caribbean, and sub-Saharan Africa are the least prepared to leverage frontier technologies and therefore face the greatest risk of missing out on technological advancements (World Economic Forum, 2023). Within the BRICS block, China ranked 35th, lower than anticipated, in the adoption of frontier technologies due to significant urban–rural differences in internet access and broadband speeds, followed by Brazil at 40th, India at 46th, and SA at 56th (World Economic Forum, 2023).

The study aims to propose an all-encompassing framework that facilitates the swift implementation of GICT within telecommunications organisations, ultimately contributing to the overarching objective of attaining environmental sustainability. Additionally, this study would provide valuable information and insights to assist both developing and global countries in their transition towards GICT.

## 2.5 THE TELECOMMUNICATION INDUSTRY

The telecommunications industry is essential because it provides the necessary infrastructure for global connectivity, communication and information sharing. It is vital to boosting economic activity, encouraging innovation, connecting individuals and communities together and supporting diverse industries. Additionally, it serves as a catalyst for societal and technological advancement. The telecommunications industry plays a fundamental role in a country's socio-economic development, with a rapidly growing number of clients and a corresponding increase in the number of critical telecommunications towers to meet the expanding demand (Deevela et al., 2023). Telecommunications networks are vital for digital transformation, prompting investment in 5G and fibre optics and driving regulatory shifts to potentially involve tech giants in funding infrastructure (Statista, 2023). Organisation A,

originating from SA, is a leading telecommunications company in Africa and a key player in the industry (Integrated Report, 2023). Organisation A, committed to digital and financial inclusion, offers a broad spectrum of services such as telecommunications, IT, digital services, the Internet of Things (IoT) and financial services and has grown beyond its South African origins to own a collection of companies across Africa, thus significantly expanding its market reach (Integrated Report, 2023).

This section will explore the following sub-constructs: providing an overview of the telecommunications industry; examining the significance of communication; assessing the importance of the telecommunications industry; analysing its global presence and impact in developing countries and investigating the environmental implications of the telecommunications industry.

### 2.5.1 Overview of the telecommunications industry

Since the discovery of electromagnetic waves in the 1860s, telecommunications has significantly shaped societal facets and advanced from the first cellular network to 5G, producing devices and services that offer high-speed communication and interactive technologies (Meena & Geng, 2022). The telecommunications industry is the key strength of a country's communication infrastructure, especially now in this period of the industrial revolution where everything is going digital (Tamuka & Sibanda, 2020). The telecommunications industry has transitioned from a monopoly to competitive markets through technological innovation and regulation; leading to lower prices, better service quality and a focus on customer acquisition and experience (Meena & Geng, 2022). The past century has witnessed the swift rise and adoption of ICT, which has fuelled the digital economy and established telecommunications infrastructure as the essential backbone of every nation's information superhighway (Tang et al., 2021). In recent years, the mobile telecommunications industry has experienced rapid growth due to the skyrocketing number of mobile subscribers, multimedia applications and data-driven services (Srivastava, Gupta & Kaur, 2020). In response to the significant growth in mobile subscribers and high-speed data requirements, cellular network operators are increasingly deploying base stations (BS) worldwide (Hossain et al., 2020). The fundamental components of a telecommunications network include mobile nodes, access networks and a backbone core network. BS serves as a crucial element of the radio access network, connecting mobile devices to the core network. Consequently, as the

number of mobile subscribers increases daily, the number of base stations also continues to increase (Srivastava et al., 2020). Gati et al.'s (2019) study indicates that energy costs form a considerable portion of the operational expenditures for large service providers, with most energy consumption stemming from access equipment such as edge points. The telecommunications industry faces an energy consumption challenge due to rapid expansion and increasing smartphone usage (Srivastava et al., 2020).

Smartphones have become one of the main resources for internet connectivity, which has revolutionised the telecommunications industry; these technologies are the key reason for innovation in developing countries, which leads to job creation and economic growth either directly or indirectly (Gillwald et al., 2018). The push for energy efficiency in mobile networks is driving regulatory authorities and network operators to consistently explore innovative technologies to enhance the entire network infrastructure (Sargam & Gupta, 2022). The telecommunications industry has transformed throughout the stages of industrialisation and information technology, adopting diverse roles that support advances in technology and advance services for countries globally (Khater, 2021). The telecommunications sector's strategies to provide value with service bundles and connectivity solutions like 5G fixed wireless access and fibre, along with their critical role in fulfilling the rising demand for edge computing, all while balancing cost-competitive pricing, expedited infrastructure rollout and environmental sustainability (Deloitte, 2023).

The telecommunications industry's future is poised to leverage neural networks, AI, machine learning and sensory digitisation; with 5G enhancing machine communications, VR streaming, cybersecurity, cloud management and edge computing, profoundly influencing future industries (Meena & Geng, 2022). In light of growing public concern about the environmental effects of economic growth, the telecommunications industry is working to reduce energy consumption, motivate the use of clean energy and encourage suppliers to adopt net-zero policies in order to reduce emissions and safeguard their brand (Deloitte, 2023). Global telecommunications operators now regard energy consumption as both a key operational cost and a sustainability initiative, aiming to evolve the ICT sector into one that diminishes its ecological footprint and supports other sectors in similar efforts. This study will assist the telecommunications industry in its transition towards greater environmental friendliness and sustainability.

### 2.5.2 Communication in the telecommunication industry

Communication is crucial in society, as it not only fulfils the need for socialisation but also acts as a medium for expression, a way to divert and relieve stress, an entertainment source, a means to create a sense of belonging and a tool to transmit values among individuals (Bose, 2021). Since electromagnetic waves were discovered in the 1860s, telecommunications have grown significantly, having a profound impact on politics, education and culture. Technological advancements, including the development of telecom towers, routers and smartphones as well as key milestones such as the inaugural 1979 cellular network, have culminated in the modern 5G network; characterised by high-speed, low-latency services for applications like video calls and 3D gaming (Meena & Geng, 2022). In recent years, there has been an increasing demand for seamless communication between anyone or anything, regardless of who or what they are or where or when the interaction takes place (Leung et al., 2021). In the early 1990s, the internet arose as a commercial powerhouse, offering an alternative to traditional circuit-switched telecommunications networks and introducing new services while also establishing a ground-breaking paradigm shift in information and communications that fundamentally transformed how people approached problems and solutions in the field (Khater, 2021).

The rapid evolution of mobile communication, with an expected eight billion new subscribers by 2030, necessitates innovative spectrum allocation solutions like cognitive radio networks to address the growing data traffic demands (Srivastava et al., 2020). Organisation A, with 44.2 million customers in SA and a strong mobile legacy, is expanding into fixed, financial and digital lifestyle markets through its System of Advantage as it evolves from a traditional TelCo into a leading African TechCo; focusing on enhancing infrastructure, increasing affordable smartphone penetration and data access and using behavioural insights to improve propositions for consumers and enterprises, aiming to lessen the digital divide in its operational regions.

### 2.5.3 Importance of the telecommunications industry

The importance of the telecommunications industry in today's world cannot be more crucial, as enhancements in telecommunications technology significantly contribute to the acceleration of globalisation and economic growth while also facilitating increasingly transnational communication and commerce (Maneejuk & Yamaka, 2020). The telecommunications

industry is important as the telecommunications infrastructure can generate network spillovers and offer benefits such as overcoming geographical limitations, lowering transaction expenses and encouraging innovative business models. Consequently, it can stimulate the growth and development of green technology, potentially influencing advancements in eco-friendly innovations (Tang et al., 2021). For example, ICT enables remote work to reduce travel related GHG emissions, promotes sharing services that reduce raw material consumption and enhances production efficiency by cutting down on intermediate raw material input (Zhang, et al., 2022). It is also important because globally telecommunications, internet access and mobile innovations will remain essential in facilitating education, training and the distribution of information about sustainable development while promoting awareness (Gotay & Ist, 2020). Since the global outbreak of the Coronavirus pandemic in 2019, which compelled people to stay indoors, telecommunications services have been and will remain vital in sustaining families, businesses and individuals (Abd-Elrahman & Ahmed Kamal, 2022). The telecommunications industry is important as it is a crucial engine for economic growth and societal progress; demonstrating resilience and significance even through economic challenges. It boosts global connectivity and productivity while also significantly improving living standards and promoting sustainable technological development.

The telecommunications industry's importance is critical for understanding the adoption of GICT within Organisation A. This sector's pivotal role in technological innovation directly influences the study's primary objective, to identify challenges in transitioning to sustainable practices. Additionally, by understanding the industry’s influence on economic and environmental dynamics, the study can address secondary objectives related to evaluating GICT adoption and formulating strategic enhancements for Organisation A. The telecommunications industry holds significant importance due to its role in driving economic advancement, contributing to global impact and consumer benefits and promoting green innovation and economic growth as outlined below.

#### *2.5.3.1 Economic advancement through the telecommunications industry*

In the early 2000s, despite the economic turbulence caused by the dotcom bubble burst and telecom crash, the telecommunications industry's important role in fostering economic growth and prosperity became increasingly apparent (Gómez-Barroso & Marbán-Flores, 2020). By bridging the digital divide and fostering the digital economy, the telecommunications industry

plays an important role in boosting productivity and promoting economic growth (Oredegbe & Zhang, 2020). Leskaj & Lazimi's (2023) study emphasises the importance of the telecommunications industry's contribution to a country's overall economic development; especially through broadband penetration which significantly boosts economic development, with a 1% increase in fixed and mobile broadband penetration resulting in a 0.08% and 0.15% increase in GDP, respectively. Mobile telephony has had a significant social effect, particularly in developing countries, becoming essential in the lives of the poorest and enhancing their socio-economic conditions; despite often being overlooked by national statistics and global poverty metrics (Gómez-Barroso & Marbán-Flores, 2020). The telecommunications industry is an important driver of productivity and economic activity, significantly contributing to the growth of various economies and industries (David & Grobler, 2020).

#### *2.5.3.2 Telecommunications industry: global impact and consumer benefits*

The United Nations Millennium Declaration's inclusion of Goal 18 in September 2000, aiming to partner with the private sector to extend telecommunications technologies' benefits universally, underscores the sector's importance in worldwide development initiatives (Gómez-Barroso & Marbán-Flores, 2020). The telecommunications industry has significantly reshaped the economic landscapes of developing countries, particularly in China and India, where its rapid growth has led to substantial transformations (David & Grobler, 2020). Advancements in telecommunications have notably enhanced consumer welfare by diversifying product options and price points, lowering search costs and empowering more informed purchasing decisions, thereby boosting overall well-being (Leskaj & Lazimi, 2023). Telecommunications expansion through broadband grants consumers access to an extensive range of goods and services potentially unavailable in local markets, which may result in lower prices and increased choice (Leskaj & Lazimi, 2023).

#### *2.5.3.3 Telecommunications industry: boosting green innovation and economic growth*

Telecommunications infrastructure is important in advancing green technology innovation by eliminating spatial barriers, lowering transaction costs and fostering innovative business models (Tang et al., 2021). Studies show that the use of broadband increases customer response, boosts sales and marketing and increases workforce flexibility, all of which contribute to significant productivity gains and cost savings from the telecommunications

industry (Leskaj & Lazimi, 2023). Tang et al.'s (2021) study indicates that relentless progress in telecommunications infrastructure, especially through programmes like China's Broadband initiative which enhances network performance and expands 5G and next-gen infrastructures, is important for merging digital technology with the actual economy and fostering superior green technology innovations.

To attain heightened productivity and economic growth substantial investment in telecommunications infrastructure is vitally important, as countries lacking robust networks may falter in reaching these goals (Oredegbe & Zhang, 2020). For effective logistics, such as "Just in Time" delivery models, telecommunications are necessary because they enable smooth communication throughout the production chain; which lowers the need for large inventories and increases operational efficiency (Leskaj & Lazimi, 2023). Oredegbe and Zhang's (2020) study offers a theoretical framework that reveals a positive correlation between the quality of public institutions and investment levels in the telecommunications sector. As broadband technology advances, it not only improves service quality and internet speed for users but also serves as a critical enabler for businesses to transition to online retailing and streamlines distribution; all while playing a pivotal role in a country's digital transformation by facilitating the integration of ICT into the economy (Leskaj & Lazimi, 2023).

Tang et al.'s (2021) study indicates that telecommunications infrastructure upgrades have a greater impact on non-state-owned businesses, especially those with more advanced levels of current technology and fewer financial constraints, and that they disproportionately spur innovation in lower-quality green technologies over higher-quality ones. The development of green technologies and economic growth have a strong connection to the telecommunications sector, which is also critically important to sustainable development and digital integration in the contemporary world. The prioritisation of environmental sustainability and efficiency within the telecommunications industry is essential, given the industry's continuous expansion and the significance of the sector as highlighted in prior literature.

### 2.5.4 Telecommunications industry, globally and in developing countries

The digital divide remains a persistent issue between developed and developing nations, particularly regarding network infrastructure (ITU, 2023b). Figure 2.7 demonstrates that mobile networks serve as the primary or sole means of internet access in LDC and several

developing nations, with an access gap in LDC for mobile signal and internet connectivity. In Europe, a significant portion of the population resides close to fibre-optic networks, while other regions have lower coverage.

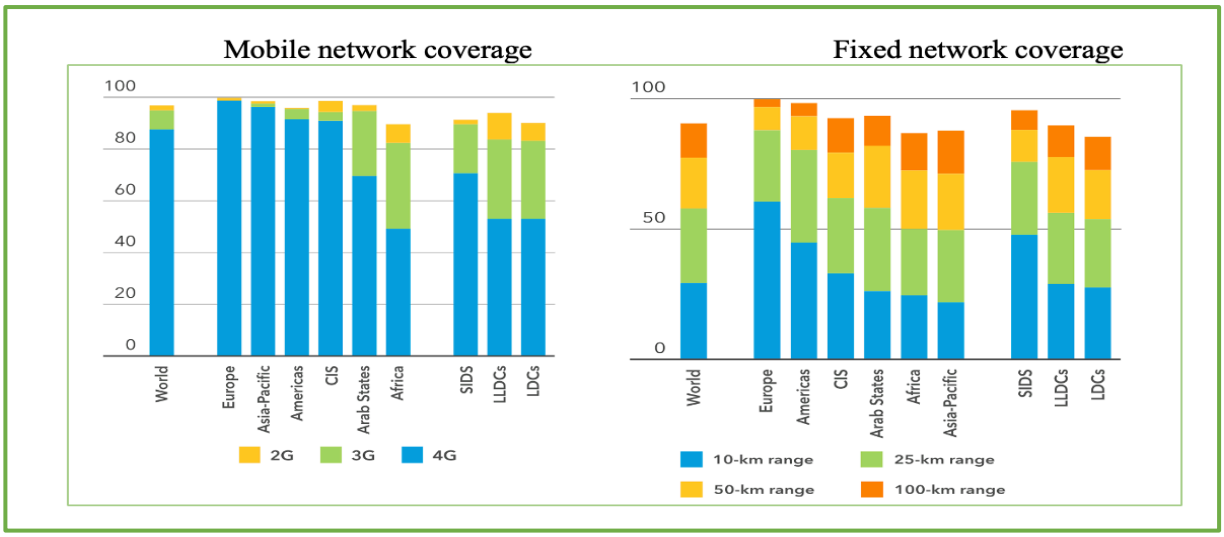



**Figure 2.7**: Mobile and FIX network coverage globally
**Source:** ITU (2023)

Figure 2.7 illustrates that, in LDC, 83% of the population is covered by mobile broadband, which is 3G or higher, compared to 95% of the global population, resulting in a 17% access gap with 8% with no mobile signal and 9% with a signal but no internet connectivity; while the global access gap is 5%, which is 2% with no mobile signal and 3% with only a 2G signal (ITU, 2023b). In Europe, over 60% of the population resides within 10 kilometres of a fibre-optic network. However, the extent of fibre-optic networks in other regions is significantly lower, with the Asia-Pacific region at 22%, Africa at 25% and the Arab States at 26% (ITU, 2023b). As the whole community depends more on ICT, it is critical to recognise the disparities in access to these resources and fight to close the gap. In order to bridge the communication gap between least developed and developed countries, mobile telecommunications infrastructure is essential. Therefore, it is crucial to ensure mobile industrial efficiency while placing an emphasis on environmental sustainability, especially as ICT advances globally. Therefore, this study will contribute valuable insights that can help enhance the efficiency of ICT systems.

### 2.5.5 Environmental impact of the telecommunications industry

The telecommunications industry is experiencing rapid expansion due to the technological revolution and increased user data demands, making it challenging for network operators to meet the growing energy needs of cellular networks while considering limited fuel reserves and increasing concerns about global warming (Hossain et al., 2020). The demand for fast, seamless services leads to increased BS deployment and antenna power, resulting in heightened CO2 emissions but also contributing to energy consumption and resource scarcity, making energy a 21st-century geopolitical issue (Srivastava et al., 2020). Global warming and climate change stem from human-generated greenhouse gas emissions, which are escalating with the growth in energy use due to rising populations and economic activities and this trend may be exacerbated by the surge in ICT usage over the last decade, potentially boosting energy consumption and subsequent GHG emissions (Raihan, 2023). The surge in telecommunications services, critical to socio-economic advancement, leads to an increased number of towers and thus higher electricity needs, necessitating a push for decarbonisation to mitigate their growing carbon footprint amid climate change concerns (Deevela et al., 2023). Since it is well established that using renewable energy sources instead of conventional ones can reduce carbon emissions, adopting green technology is essential for protecting the environment and may help achieve the UN's "green is clean" goal (Batool et al., 2019).

As awareness of environmental concerns and global warming related to communication technologies grows, researchers have been pursuing solutions to reduce energy consumption in the telecommunications industry (Srivastava et al., 2020). Numerous nations are developing their infrastructures and production capacities to capitalise on the advantages of technology and worldwide communications. GIT can positively impact global communities by overseeing hazardous materials and developing information systems that optimise natural resource utilisation in the creation of goods and services (Gotay & Ist, 2020). Telecommunications organisations have a significant impact on global connectivity, economic growth and social development by providing essential communication services and infrastructure; thus, it is essential that these companies embrace ecologically friendly practices. This study would address the environmental impact of the telecommunications industry, by identifying and proposing strategies for implementing GICT practises within telecommunications organisations.

### 2.5.6 Telecommunication organisation's Green ICT commitments and sustainability strategy

Telecommunications organisations are actively involved in transitioning to GICT, adopting various strategies to reduce their environmental footprint and promote sustainability. The following notable examples are shown in Table 2.3 below.

**Table 2.3: Summary of a few prominent telecommunications organisation's Green ICT strategies and goals**

| Telecommunication organisation | Greening targets and strategy | Source |
|---|---|---|
| Vodafone | Vodafone is committed to becoming a net-zero emissions entity, planning to switch entirely to renewable energy by 2025 and aiming for net-zero emissions in its operations by 2030 and across its value chain by 2040. Their approach includes improving energy efficiency, transitioning to renewable energy sources, investing in renewable technology like solar and wind and promoting the use of electric vehicles. Moreover, Vodafone is focused on reducing carbon in its products and operations, incentivising suppliers to lower their carbon output and engaging customers in sustainability efforts. This holistic approach to sustainability spans across Vodafone's operations, supply chain and consumer relations. | (Vodafone, 2023) |
| AT&T | AT&T is committed to achieving carbon neutrality by 2035, with a plan that includes reducing greenhouse gas emissions to net-zero for their operations and collaborating with suppliers and customers to reduce their environmental impact. The company has reduced emissions by 41% since 2015 and is focused on energy efficiency, with 161,000 projects contributing to substantial savings. AT&T is also transitioning to renewable energy, ranking high among corporate renewable energy buyers in the US and has set a gigaton goal to help customers reduce a gigaton of emissions by 2035. In waste management they aim to reduce landfill waste by 30% by 2030 and are moving towards a circular economy by repurposing and recycling electronic devices. AT&T is encouraging suppliers to adopt science based GHG targets, achieving their target with 50% of suppliers by 2022, and aims for 80% of procurement spending to be covered by sustainability assessments by 2025. These efforts are integral to AT&T's strategy to address climate change and promote sustainable practices across its operations and supply chain. | (AT&T, 2022) |
| Verizon | Verizon is targeting a significant reduction in their direct and power-related emissions to net-zero by 2035, with a 53% cut by 2030 from a 2019 baseline. They also aim to lower emissions associated with their value chain activities by 40% within the same timeframe. Their strategy includes a shift to 50% renewable energy for electricity by 2025 and 100% by 2030. Energy efficiency measures across their operations involve upgrading to fibre technologies, optimising network energy use and transitioning their vehicle fleet to hybrid models. To finance these initiatives, they've issued green bonds and are engaging in renewable energy purchase agreements. Verizon's approach is comprehensive, | (Verizon, 2023) |

| | | |
|---|---|---|
| | encompassing policy monitoring, innovative climate solutions and a focus on supply chain resilience to address climate-related risks. | |
| Deutsche Telekom | Deutsche Telekom has committed to a sustainable future with its strategy to source 100% of its electricity from renewable energies, already achieved group wide as of 2021, and aims for climate neutrality in direct and indirect emissions by 2025, with a broader goal of complete climate neutrality, including indirect emissions, by 2040. To facilitate this, the company has adopted a comprehensive sustainable mobility strategy, which includes transitioning to electric vehicles for its fleet by 2023 and promoting sustainable commuting practices through initiatives like the EcoShift app and the planned Mobility as a Service (MaaS) platform set to launch in 2023. Deutsche Telekom ensures compliance with its sustainability targets through stringent reporting against the T Global Reporting Initiative (GRI), the Task Force on Climate-Related Financial Disclosures (TCFD) and the German Sustainability Code, underpinning its dedication to reducing its environmental impact while transitioning to cleaner energy and transportation solutions. | (Deutsche Telekom, 2022) |
| Orange | Orange Business Services has embedded environmental sustainability within its strategic framework, aiming to align with the Engage 2025 plan's objectives of business growth coupled with robust environmental performance. Targeting a 30% reduction in their carbon footprint by 2025 and net-zero emissions by 2040, the Green Act programme is a key pillar in this strategy, focusing on integrating the most pertinent UN Sustainable Development Goals into the company's operations, particularly those related to responsible consumption and climate action. In 2020, a carbon footprint calculator was developed to enhance the visibility of the company's commitment to these goals, particularly through efficient energy use in data centres measured by the Power Usage Effectiveness metric, establishing Orange Business Services as a leader in sustainable digital transition. | (Orange, 2023) |
| Nippon Telegraph and Telephone (NTT) | NTT Ltd. is actively addressing climate change through a comprehensive strategy that includes emission reductions validated by the Science-Based Target Initiative (SBTi) and adherence to the Task Force on Climate-Related Financial Disclosures (TCFD) guidelines. The company conducts quarterly assessments of sustainability-related risks, including direct emissions from their operations, indirect emissions from energy consumption and emissions from their value chain. They aim to achieve net-zero greenhouse gas emissions by 2040, with interim targets for significant emission reductions by 2030. NTT Ltd. is also progressing towards using 100% renewable energy in their data centres by 2030 and in all offices and facilities by 2035, as part of their commitment to the Paris Agreement's 1.5-degree pathway. | (NTT Data, 2023b) |
| Telefónica | Telefónica is actively working towards a sustainable future with a goal of net-zero emissions by 2040 and complete reliance on renewable energy by 2030. The company has implemented a circular economy approach; prioritising the reuse and recycling of materials and aiming to refurbish 90% of customer equipment by 2024. They have integrated sustainability into their corporate governance and incentivised employees to meet emission reduction targets. In 2022, Telefónica recycled 98% of their waste and advanced digital solutions that contributed to exceeding their carbon emission reduction goals for customers. They also focus on eco-efficiency in water and paper use and are developing digital solutions like IoT and AI to optimise resource use and energy | (Telefónica, 2022) |

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| | consumption across B2B and B2C platforms, driving both digital and green transitions for a more competitive and environmentally conscious economy. | |
| BT Group | BT is vigorously pursuing a transition to a low-carbon, circular economy with a commitment to net-zero emissions from its operations by March 2031 and its entire value chain by March 2041. Achieving a 56% cut in carbon emissions intensity as of now, BT aims for an 87% reduction by 2031. All electricity used is sourced from renewables and the company is transitioning to electric vehicles, having added 1,000 to its fleet, which has significantly cut CO2 emissions. BT's network efficiency and building decarbonisation, including consolidating sites to BREEAM-Excellent standards, are key strategies. They have reduced Scope 3 emissions by 21% since FY17 and are engaging suppliers to commit to science-based targets. Customer-focused initiatives aim to prevent 60 million metric tonnes of CO2 emissions by 2030 through efficient technology solutions. Moreover, BT is working towards zero operational waste in landfills by 2030 and has a high global recycling rate. Their environmental stewardship extends to biodiversity efforts and water usage optimisation. | (BT Group plc, 2023) |
| Telenor | Telenor is dedicated to reducing its environmental impact, aiming for a 57% reduction in direct and indirect energy emissions by 2030 and pushing 68% of its suppliers to adopt science-based climate targets by 2025. They've made progress by decreasing direct emissions from owned resources and purchased energy emissions in 2022, enhancing solar energy use at Asian facilities and engaging in renewable energy sourcing in Europe. Telenor participates in industry efforts to promote a circular economy and aims to utilise its digital platforms to assist others in lessening their environmental footprint. In 2023, Telenor planned to further embed circular economy approaches in their strategy, focusing on biodiversity, and continue to advocate for renewable energy solutions, particularly in Asia. | (Telenor, 2022) |
| Swisscom | Swisscom is targeting climate neutrality across its value chain by 2025, aiming to reduce CO2 emissions by over 90% from 1990 levels, using 100% renewable energy and enhancing energy efficiency. The company is also striving to create a positive CO2 impact by enabling customers to reduce emissions through its services. Swisscom's goal is to be among the top three Swiss ICT employers by 2025, advocating for diversity and equal opportunities while expanding ultra-fast broadband access and reinforcing digital media skills nationwide. Adhering to the Science-Based Targets initiative, Swisscom has set an ambitious group-wide net-zero emissions target by 2035 and will focus on circular economy and sustainability governance as part of its 2025 strategy, while also supporting economic growth and social conditions in its supply chains. | (Swisscom, 2022) |
| MTN | MTN Group, a leading African telecommunications company, is actively progressing its sustainability agenda with the goal of achieving net-zero emissions by 2040, underpinned by a governance framework that ensures accountability and performance monitoring across its operations. In 2022, MTN integrated financial and impact materiality into its reporting and reinforced executive accountability by associating sustainability metrics to remuneration. The company's Project Zero initiative concentrates on reducing GHG emissions by improving energy efficiency and increasing renewable energy use, while Project | (MTN Group Limited, 2022) |

| | | |
|---|---|---|
| | Infinity promotes circular economy principles by lengthening the lifecycle of equipment. MTN also works collaboratively with suppliers to promote emission reductions throughout its value chain. Committed to environmental stewardship, MTN is creating comprehensive policies and strategies for water and waste management to support the resilience and sustainability of its diverse African and Middle Eastern markets. | |
| Telkom SA | Telkom has pledged to becoming carbon neutral by 2035 and aims for net-zero emissions by 2040. Their direct emissions, largely from the operation of diesel generators due to power cuts, increased by 53% in FY2023, but they have offset some impact by installing energy storage solutions like lithium batteries at multiple sites. Their indirect emissions from purchased energy decreased by 22.3% due to energy-saving measures and equipment recovery. With less than 1% of energy use currently coming from renewables, Telkom plans to formalise net-zero targets with the Science-Based Targets initiative. For other indirect emissions encompassing their entire value chain, they identified four key categories and recorded 949,515 tCO2e for FY2022 as a baseline for target reductions. In waste management, they increased e-waste recycling by 189% and reduced general waste to landfills by 9%, aiming for a 75% reduction by 2030. In addition, they achieved a 7% reduction in potable water use and are exploring innovative conservation methods. | (Telkom, 2023) |

**Source:** Author's compilation (2025)

## 2.6 THE ORGANISATION UNDER STUDY

Organisation A is a leading telecommunications and digital technology firm in Africa, renowned for its extensive mobile network coverage and commitment to connectivity, financial services and sustainability. They prioritise bridging the digital divide, aligning with the UN sustainable development goals and regional development plans. Organisation A emphasises environmental responsibility and leverages digital networks to address climate change. Their strategic objectives focus on innovation, connectivity and sustainability, contributing to socio-economic development in Africa. The sub-construct in this study will provide an in-depth examination of the organisation being investigated, offering a comprehensive overview of its key aspects and characteristics.

### 2.6.1 Overview of Organisation A

Since its founding in 1994, Organisation A has significantly grown from its beginnings in SA, spreading its mobile network reach to Tanzania, the Democratic Republic of the Congo, Mozambique, Lesotho and Kenya (Integrated Report, 2021). Organisation A's group, a

prominent African organisation that includes Safaricom, focuses on connectivity and financial services; serving 123.7 million customers across consumer and enterprise segments with offerings such as telecommunications, IT, digital, IoT and financial services (Integrated Report, 2021). Organisation A is currently experiencing a thrilling phase as they expedite their shift from a conventional telecommunications company to a digital technology firm, while maintaining their dedication to creating a robust business that promotes digitalisation, innovation, connectivity, transformation, inclusivity, equality and sustainability; all of which serve to reinforce their system of advantage (Integrated Report, 2021).

Their strategy focuses on achieving targets in three key areas: digital society, inclusion for all and the planet; ensuring that Organisation A operates responsibly and ethically in every location (Sustainability Report, 2022). The UN SDGs envision a better and more sustainable future for everyone, with African nations committed to implementing the SDG-aligned African Union Agenda 2063 and South Africa's National Development Plan (Sustainability Report, 2022). As an enabler, their purpose is to support governments, communities, enterprises and individuals by delivering their strategy in a manner that facilitates the accomplishment of the SDGs (Sustainability Report, 2022). They believe business success should not come at the cost of the environment and they are committed to reducing the impact of their activities (Sustainability Report, 2022). Their digital networks and technologies can play a key role in mitigating climate change (Sustainability Report, 2022). Digitalisation is key to saving energy, using natural resources more efficiently and creating a circular economy (Sustainability Report, 2022). Organisation A is striving to halve GHG emissions by 2025 and fully transition to renewable energy while mitigating long-term transition risks through active regulatory monitoring, energy efficiency investments and clear communication of its sustainability strategy to preclude reputational risks and align with stakeholder expectations (TFCD, Report 2023).

In FY2023, Organisation A's analysis suggested that early policy interventions for a low-carbon economy pose transition challenges; delayed responses lead to disruptive changes and inaction incurs the greatest financial costs due to severe climate hazards, prompting the integration of risk mitigation and energy efficiency investments into their strategic and financial planning in anticipation of a net-zero future by 2050 (TFCD Report, 2023). Through collaboration with Eskom and implementing virtual wheeling technology, Organisation A seeks to counter its emissions by channelling renewable energy into the national grid, offering a blueprint for businesses to mitigate South Africa's energy challenges (Integrated Report, 2023). Organisation

A, in response to COP27's call, commits to a sustainable, low-carbon future through global cooperation and by reducing its digital society's emissions; aiming to protect the environment and ensure health, economic and social well-being (ESG Report, 2023). This demonstrates that one of Organisation A's strategic objectives is to transform into a GICT organisation. This study would provide practical assistance and valuable insights to Organisation A by addressing specific challenges, improving operational efficiency and enhancing overall performance. Through thorough analysis and research, the study would offer evidence-based recommendations that can support Organisation A in achieving its environmental goals and maximizing its potential for success.

## 2.7 CONCLUSION

Chapter 2 presents a comprehensive examination of the importance and implementation of GICT practices within the ICT sector. It underscores the environmental imperative for adopting such practices, particularly given the significant impact of ICT on global ecosystems. These comprise a general lack of awareness and comprehension of GICT, organisational cultural barriers that impede change, financial difficulties that limit investment in green technology and problems with regulations and policies that do not encourage or support the transition. The literature review brings to light the complexity of these challenges, suggesting that they are not just technical but also socio-economic and institutional. It suggests that any strategy for transition must address the multifaceted nature of these challenges and barriers. Furthermore, the chapter hints at the need for a tailored approach to understand and overcome these challenges within different contexts, particularly in developing countries where the dynamics may differ significantly from developed regions.

As the chapter sets the stage for a focused study on a South African telecommunications company, it suggests that such a study could yield specific insights into the nature of these obstacles within the South African context. It posits that identifying and understanding the unique challenges faced by this company could lead to targeted recommendations that are relevant and effective for overcoming the challenges and barriers to GICT adoption, thus contributing to the broader global effort of reducing ICT's environmental footprint.

The next chapter presents the underpinning theory, GITAM, that forms the basis of this study and will be explored in detail in part B of the literature review, Chapter 3.

# CHAPTER 3
# LITERATURE REVIEW – PART B
# UNDERPINNING THEORIES

## 3.1 INTRODUCTION

Underpinning theories are crucial as they provide a comprehensive understanding by considering both technical and social contexts, aiding in data interpretation and analysis within research (Mkhomazi & Iyamu, 2013). In this study, an examination of various underpinning theories is undertaken to establish a solid foundation for understanding the complexities of technology adoption. The theories which are analysed and evaluated in this chapter in order to identify which theory is best suited as the underpinning theory for this study include the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), Diffusion of Innovations (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), G-readiness, the Technology-Organisation-Environment (TOE) framework, the Technology Acceptance Model (TAM) and the Green Information Technology Adoption Model (GITAM). The content of Figure 3.1 presents the structure for this chapter.

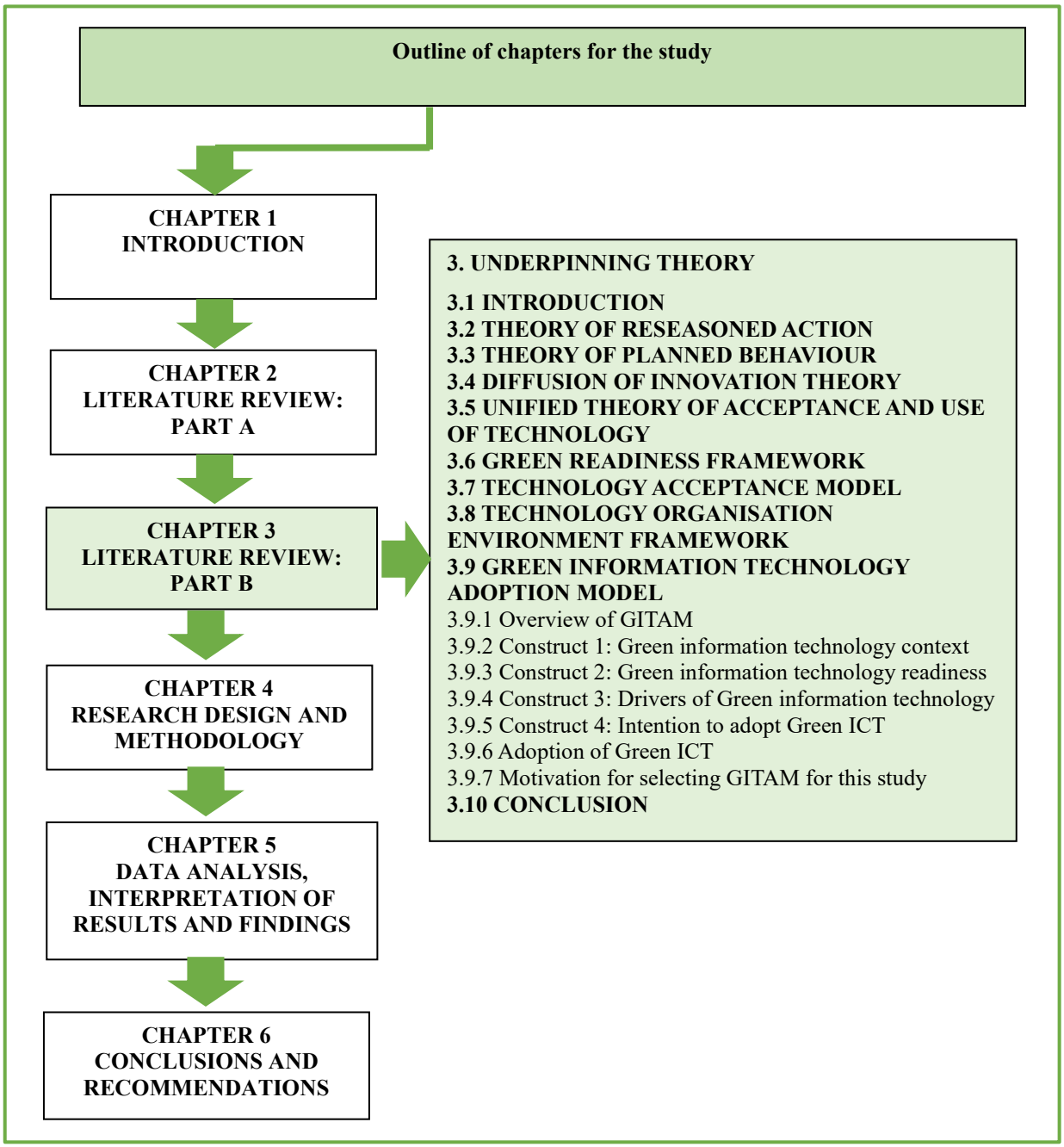



**Figure 3.1**: Outline of Chapter 3

**Source:** Author's compilation (2024)

## 3.2 THEORY OF REASONED ACTION

Dulany's theory influenced Fishbein's 1967 research; highlighting how anticipated outcomes and subjective norms shape intentions, differentiating attitudes towards actions from objects, with action-related attitudes more accurately predicting behaviour (Al-Suqri & Al-Kharusi, 2015). Fishbein and Ajzen formalised the Theory of Reasoned Action (TRA) in 1979,

explaining individual behaviour through behavioural intention, attitude, subjective norm and underlying beliefs, as comprehensively presented in their 1975 book (Yzer, 2017). Figure 3.2 illustrates Fishbein and Ajzen's TRA model below.

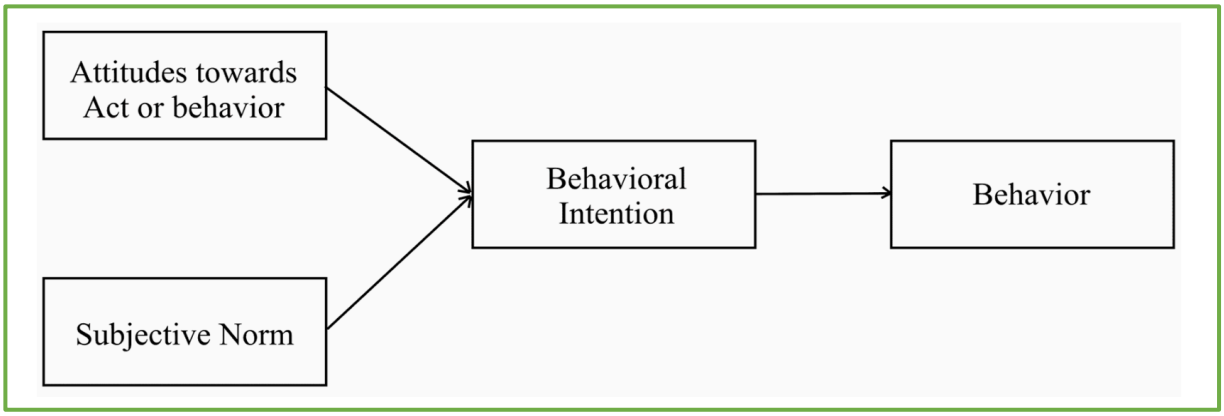



**Figure 3.2:** Theory of reasoned action
**Source:** Fishbein & Ajzen (1975)

Figure 3.2 demonstrates how behavioural intention, attitudes towards the behaviour and subjective norms determine behaviour. TRA posits that behaviour is driven by attitudes and the influence of others, leading to behavioural intention, which ultimately manifests as actual behaviour (Ekawati, Wardana, Yasa, Kusumadewi & Tirtayani, 2023). TRA suggests that attitudes and subjective norms, influenced by accumulated beliefs about a behaviour's outcomes and their favourability, shape behavioural intentions; with health messages potentially altering attitudes by addressing these beliefs (Yzer, 2017). The theory proposes that individuals make rational decisions about their actions based on anticipated outcomes, where positive expectations foster favourable attitudes and increased adoption, negative expectations deter behaviour and subjective norms also play a crucial role (Wu, 2020). A subjective norm is shaped by an individual's beliefs about whether key referents, like friends or colleagues, support or oppose a behaviour and is influenced by the individual's motivation to comply with these referents (Yzer, 2017). TRA assumes behaviours are under complete self-control, expecting intentions to lead to actions, but this is restrictive as it overlooks challenges like required skills, cooperation and resources (Sok, Borges, Schmidt & Ajzen, 2021).

TRA has proven effective in predicting behavioural variability across various contexts, populations and behaviours; leading Ajzen to modify it to include behaviours not entirely within an individual's control (Hagger, 2019).

TRA was not chosen for this research as it presumes complete behavioural control and does not account for the complex external influences, resource constraints and organisational dynamics that are crucial in the transition to GICT within Organisation A.

### 3.3 THEORY OF PLANNED BEHAVIOUR

Seminal works by Ajzen (1985) state that the Theory of Planned Behaviour (TPB) extends TRA by including perceived and actual control to predict behaviours, recognising that intentions may not always lead to actions due to various influencing factors. TPB strengthens TRA by adding a third element, perceived behavioural control; which reflects an individual's ease or difficulty with an action and posits that the intensity of one's intent is a decisive factor in the actual execution of the behaviour (Kumar, Raut, Upreti, Alam, Shafiuddin & Verma, 2023). TPB incorporates beliefs about actual and perceived control over actions, enhancing the influence of personal attitudes and societal norms on intentions, unlike TRA, which assumes full control over behaviour (Ajzen, 2020). Further seminal works by Ajzen (1991) state that TPB suggests that the likelihood of performing a behaviour is determined by the individual's intention and the ability to execute the action; where intention reflects motivational factors and actual execution depends on volitional control as well as the availability of necessary opportunities and resources. Figure 3.3 illustrates the TPB model below.

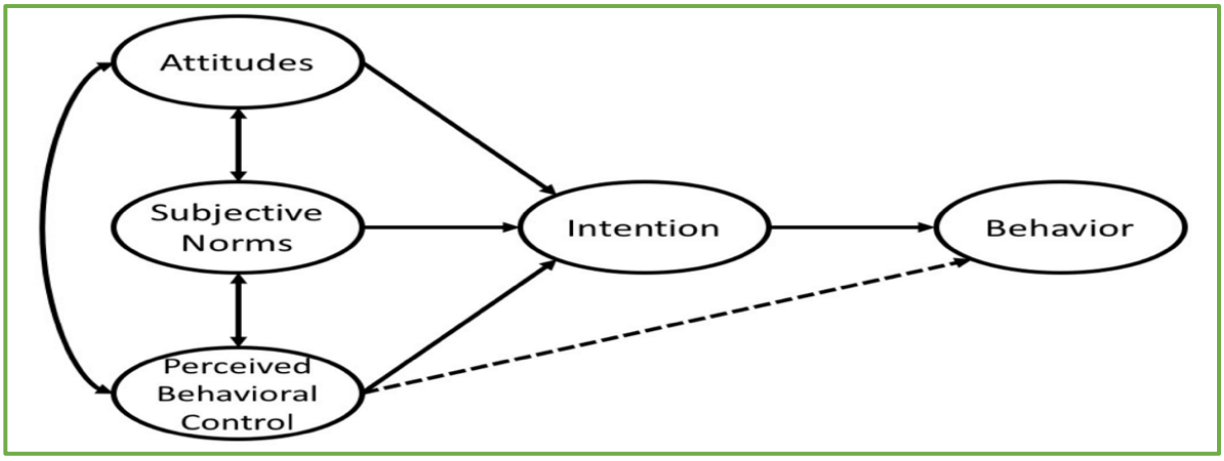



**Figure 3.3:** Theory of Planned Behaviour

**Source:** Ajzen (1991)

Figure 3.3 suggests that there are three components that influence an individual's intention, which in turn can predict the likelihood of performing a specific behaviour. These components consider both internal factors (attitudes and perceived behavioural control) and external factors (subjective norms). TPB assesses how various factors shape intentions and indirectly influence behaviour, with these intentions being affected by personal appraisal of the behaviour (attitude), social influences and pressures (subjective norm) and the perceived ease or difficulty of performing the behaviour (perceived behavioural control) (Wu, Liang, Wu & Hong, 2021). Bosnjak, Ajzen and Schmidt (2020) explain that TPB posits that individual behaviour is shaped by behavioural beliefs (attitudes), normative beliefs (social pressures) and control beliefs (perceived control); which together influence the intention to act, leading to actual behaviour if the individual has sufficient control. TPB is known for its empirical validity and effectiveness in predicting and modifying behaviour, providing a focused model and methodological tools despite some research application challenges (Ajzen, 2020). TPB posits that perceived behavioural control moderates the influence of attitudes and social norms on intentions and behaviour but while early empirical evidence was weak, recent studies highlight its significant role, suggesting a need for further research on these interactions (La Barbera & Ajzen, 2020). TPB offers a readily understandable and empirically validated structure, complete with established guidelines for measuring its constructs, simplifying research for those without a social psychology background (Sok et al., 2021).

TPB was not chosen for this research because it focuses on individual behaviour rather than organisational complexities, does not account for broader technological, organisational and environmental factors and overlooks the significant external influences and barriers involved in the adoption of GICT within an organisation.

## 3.4 DIFFUSION OF INNOVATION THEORY

The Diffusion of Innovations (DOI) theory, developed by Everett M. Rogers, originated from studying the rapid adoption of hybrid corn among Iowa farmers in 1928 and evolved into a comprehensive model to predict and facilitate technological spread by understanding individual decision-making within homogeneous populations (García-Avilés, 2020). Seminal works by Rogers (2003) state that diffusion is the process by which an innovation spreads through specific channels over time within a social system; characterised by novelty, uncertainties and risks, which are mitigated through information acquisition, involving the

innovation, communication channels, time span and social system members. DOI focuses on individuals' evolving perceptions of innovation through interactions, emphasising the need to understand the diffusion process and adoption changes (Silva, Braz, Cavalcante & Alves, 2022). DOI posits that innovation adoption and diffusion can be analysed at different levels and typically follow a characteristic pattern over time (Kuo, McManus & Lee, 2022). According to Dearing and Cox (2018), diffusion is a social process measured by adoption timing and implementation extent in organisations, often following an S-shaped curve with initial slow uptake, rapid growth and eventual slowdown. Figure 3.4 illustrates the DOI model by Rogers below.

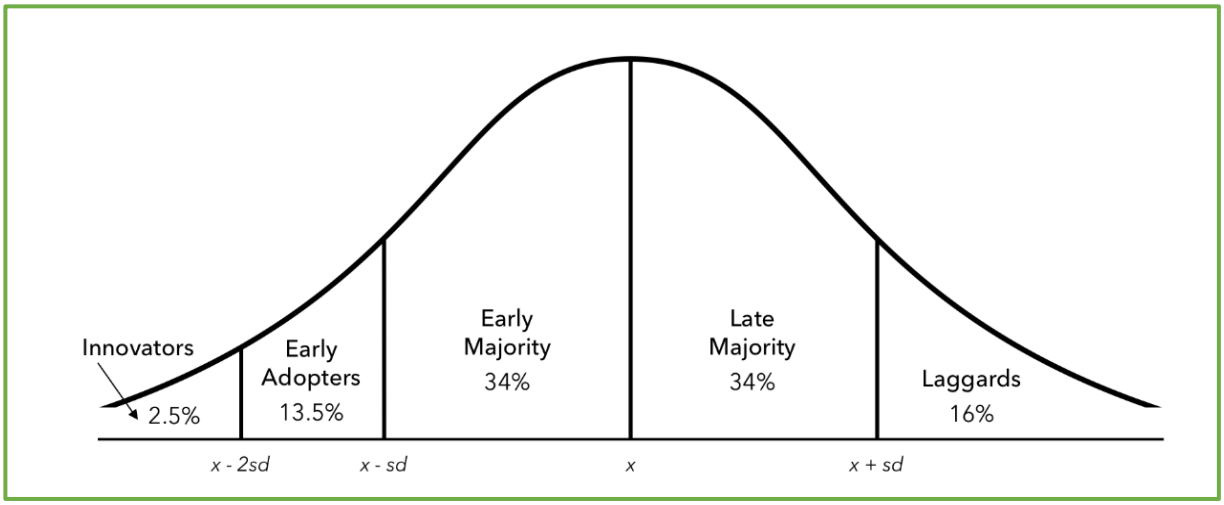



**Figure 3.4:** Diffusion of innovation theory

**Source:** Rogers (2003)

Figure 3.4 categorises adopters of new technologies into five groups: innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%). Seminal work by Rogers (2003) state that this model illustrates how innovations spread through a population over time, following a normal distribution curve. Innovation adoption depends on its perceived benefits, compatibility, complexity, trialability and observability; spreads through communication channels and progresses through the stages of knowledge, persuasion, decision, implementation and confirmation. It is influenced by social system structure and member innovativeness and is categorised by innovators, early adopters, early majority, late majority and laggards. Fujii (2022) identified that innovators initiate adoption, followed by influential early adopters, a cautious early majority who bridge widespread adoption, a sceptical late majority who adopt under peer pressure and finally the resistant laggards. To gauge an innovation's success, one must understand its diffusion, which involves the

transmission of the innovation over time through communication channels among members of a social system (Silva et al., 2022). The essence of innovation diffusion is the exchange of information, where consumers learn about and share new products and ideas, significantly influenced by the perceived relative advantage and demand for innovation (Fujii, 2022). When encountering a significant innovation, individuals or entities seek information to evaluate its cost, effectiveness, simplicity, compatibility, observability and trialability to determine its potential for adoption (Dearing & Cox, 2018). The principles of DOI require re-evaluation for networked and complex technologies due to the consideration of collective behaviours, standards, critical mass and existing infrastructures; and have gained interest across various fields as researchers and practitioners explore its application within and between organisations (García-Avilés, 2020).

DOI theory was not chosen for this research because it primarily focuses on the spread of innovations among individuals or organisations over time, rather than addressing the specific organisational, technological and environmental complexities involved in the transition to GICT within Organisation A. Additionally, DOI does not adequately account for the systemic barriers and institutional policies that can significantly impact the adoption of GICT technologies.

## 3.5 UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY

The Unified Theory of Acceptance and Use of Technology (UTAUT) is used to predict and understand the factors influencing the acceptance and use of technology (Blut, Yee, Chong, Tsiga & Venkatesh, 2021). Seminal works by Venkatesh, Morris, Davis and Davis (2003) developed UTAUT by methodically synthesising and empirically testing elements from eight established information technology acceptance models using data from six organisations. Venkatesh and colleagues integrated eight established theories of technology acceptance—TRA, TPB, TAM, Model of PC Utilisation, DOI, Motivational Model and Social Cognitive Theory—into a singular, comprehensive framework known as UTAUT and charted the evolution of these theories in a chronological graph, categorising their development into four main trajectories within the behavioural sciences over time (Momani, 2020). Figure 3.5 illustrates the UTAUT model below.

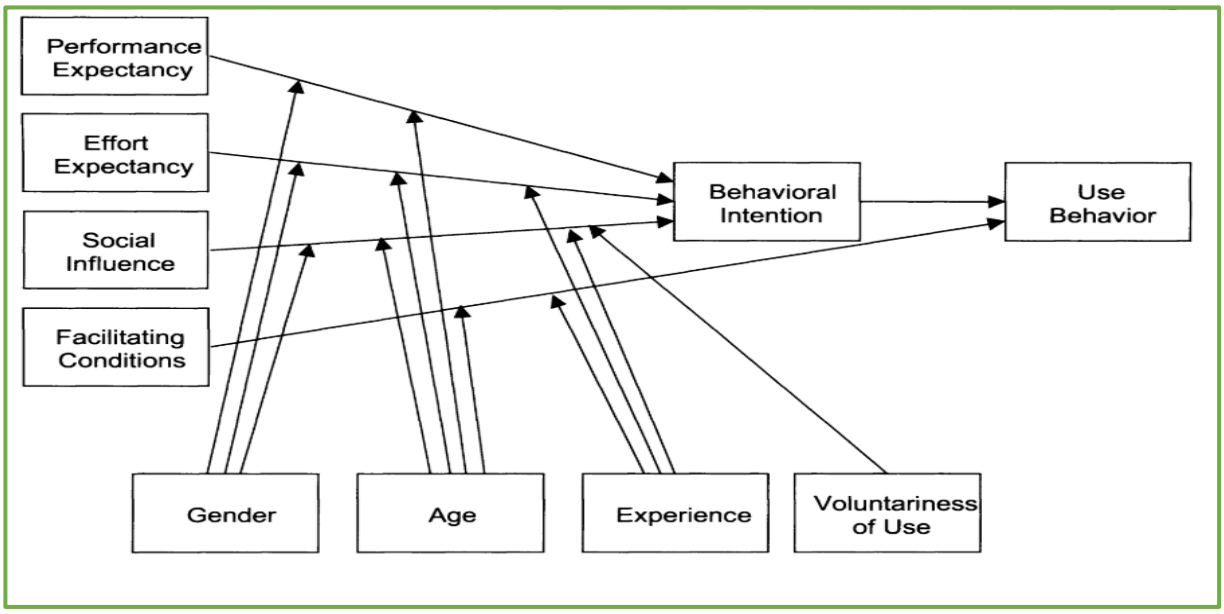



**Figure 3.5:** Unified Theory of Acceptance and Use of Technology

**Source:** Venkatesh, Morris, Davis & Davis (2003)

Figure 3.5 shows how performance expectancy, effort expectancy, social influence and facilitating conditions impact behavioural intention and actual use behaviour. Factors such as gender, age, experience and voluntariness of use moderate these relationships; offering a comprehensive framework for understanding technology adoption and usage within organisations. UTAUT posits that the intention to use technology is driven by performance expectancy, effort expectancy and social influence; while actual use is influenced by intention and facilitating conditions, moderated by experience, voluntariness, gender and age, explaining 70% of variance in usage intention with a streamlined structure of four main effects and four moderators (Venkatesh et al., 2003). Blut et al. (2021) mentioned that UTAUT's main constructs—performance expectancy, effort expectancy, social influence and facilitating conditions—determine an individual's intention and the actual usage of technology; emphasising benefits, ease of use, peer expectations and support infrastructure. UTAUT, originally for obligatory technology use in organisations, has been enhanced to include hedonic motivation, price value and habit factors, making it robust and adaptable for studying new technology adoption by simplifying the prediction of usage behaviour and assessing individual technology perceptions (Momani, 2020). UTAUT focuses on system benefits, ease of use, peer pressure and support; moderated by age, gender, experience and voluntariness, but has been criticised for overlooking user roles, buyers, developers and the impact of social networks and informal learning (Rangel & Humphrey-Murto, 2023).

UTAUT was not chosen for this research because it primarily focuses on individual user acceptance and usage behaviours, without adequately addressing the organisational, technological and environmental complexities involved in the transition to GICT within an organisation. Additionally, UTAUT neglects the roles of buyers and developers, as well as the impact of social networks and informal learning, which are important factors in the adoption of GICT.

## 3.6 GREEN READINESS FRAMEWORK

Molla and Cooper (2010) developed the G-readiness framework, which is an integrated approach to assessing and implementing GICT strategies across attitudes, policies, practices, technologies and governance structures within an organisation. G-readiness is a holistic framework designed to evaluate an organisation's preparedness and capability to adopt and implement ICT in a way that is both sustainable and environmentally friendly (Dewiyana, Muda & Silalahi, 2023). Achieving G-readiness is a multifaceted effort that demands a shift in attitude, technology, policy, practice and governance, which is simpler for inherently green companies than for established ones; without it, companies may fail to fully capture the benefits of GICT, potentially missing out on sustainability-linked competitive advantages and business success (Molla & Cooper, 2010). Ghani (2022) created the Green Information Technology Readiness Framework, or G-readiness, as a tool to assist organisations in assessing their readiness for implementing environmentally sustainable information technology practices. Figure 3.6 illustrates the G-readiness framework below.

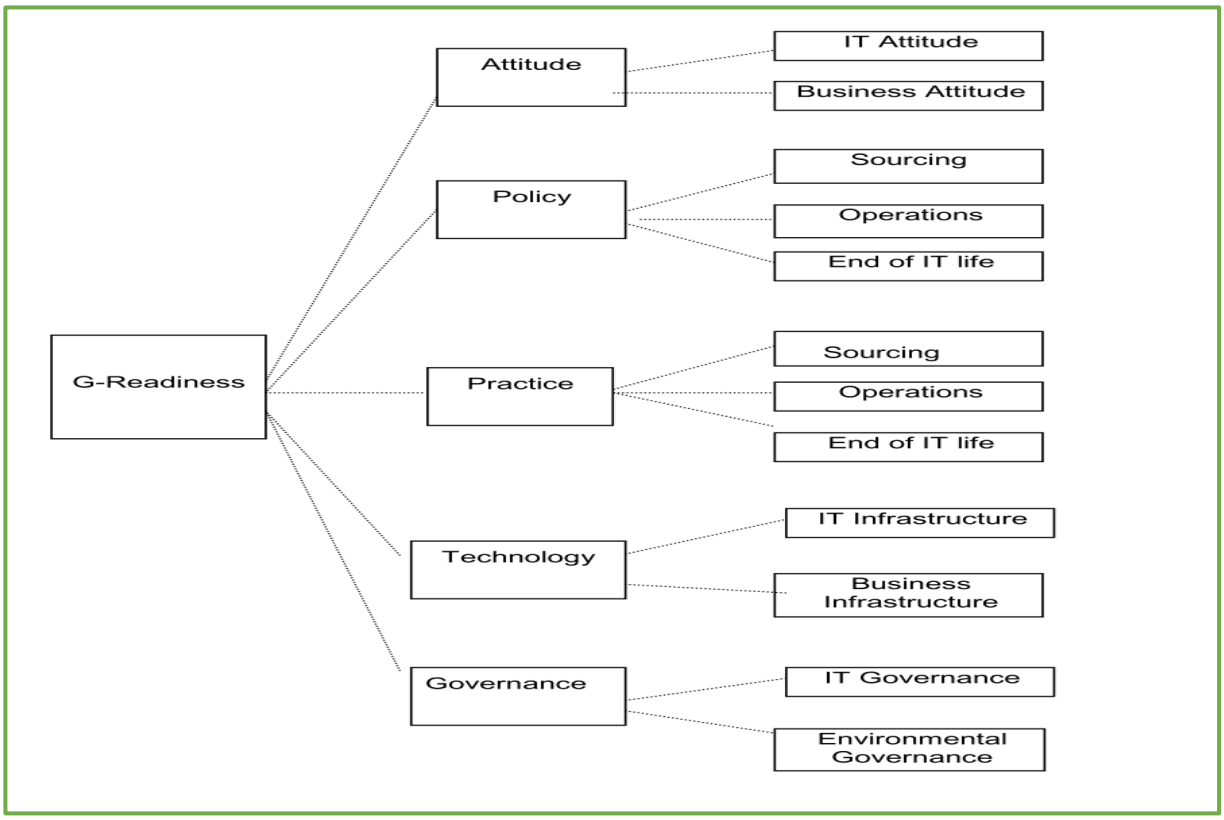



**Figure 3.6:** Green readiness framework

**Source:** Molla & Cooper (2010)

Figure 3.6 evaluates an organisation's readiness for GICT adoption across five dimensions: attitude, policy, practice, technology and governance. GICT readiness involves leadership attitudes, sustainable IT policies, integrating environmental considerations into IT practices, building green technological infrastructure and establishing governance structures for accountability and effective resource management (Molla & Cooper, 2010). The G-readiness framework assesses leadership attitudes towards IT impacts, policy readiness for green implementation, sustainable IT practices, green infrastructure construction and governance for managing GICT initiatives (Ghani, 2022). The success of GICT in organisations relies on the attitudes of decision-makers and employees, establishing environmental policies and implementing sustainable practices in IT procurement, operations and equipment recycling (Hernandez, Juanatas, Escolano & Elvambuena, 2022). G-readiness is about gauging an organisation's capacity and willingness to adopt GICT, concerned with their motivations (why), whereas other frameworks detail the specific GICT solutions and their implementation (what and how) (Hankel et al., 2019). G-readiness quantifies an organisation's GICT infrastructure

relative to others, offering a metric for gauging a business's advancement towards engaging in the global, low-carbon digital economy (Ahmad, 2020).

The G-readiness framework was not chosen for this study because it primarily focuses on evaluating an organisation's overall readiness for GICT adoption in a broad context, without delving deeply into the specific challenges and barriers unique to a telecommunications organisation. Additionally, it does not provide sufficient emphasis on employee awareness, involvement and perceptions, which are critical aspects of this study's secondary objectives. Furthermore, G-readiness was not selected due to the complexity and depth required for this study.

## 3.7 TECHNOLOGY ACCEPTANCE MODEL

The Technology Acceptance Model (TAM), derived from the Theory of Reasoned Action (TRA), enhances predictive power in user behaviour studies by incorporating perceived usefulness and perceived ease of use (Putri, Widagdo & Setiawan, 2023). TAM, building on Fishbein and Ajzen's TRA, posits that user behaviour is influenced by attitudes and social acceptance, where perceived ease of use enhances perceived usefulness, both of which affect the user's attitude and intention to use the technology, without a reciprocal influence from perceived usefulness to perceived ease of use (Mailizar, Almanthari & Maulina, 2021). In 1989, Fred Davis built upon TRA to introduce and enhance TAM, providing a theoretical foundation to clarify the relationship among attitudes, intentions and behaviour (Alfadda & Mahdi, 2021). To and Trinh (2021) underline that TAM explains that individuals' decisions to adopt new technologies are driven by their attitudes, which are influenced by perceived usefulness and ease of use, emphasising these factors as key determinants of their readiness to embrace technological innovations. Figure 3.7 illustrates the TAM below.

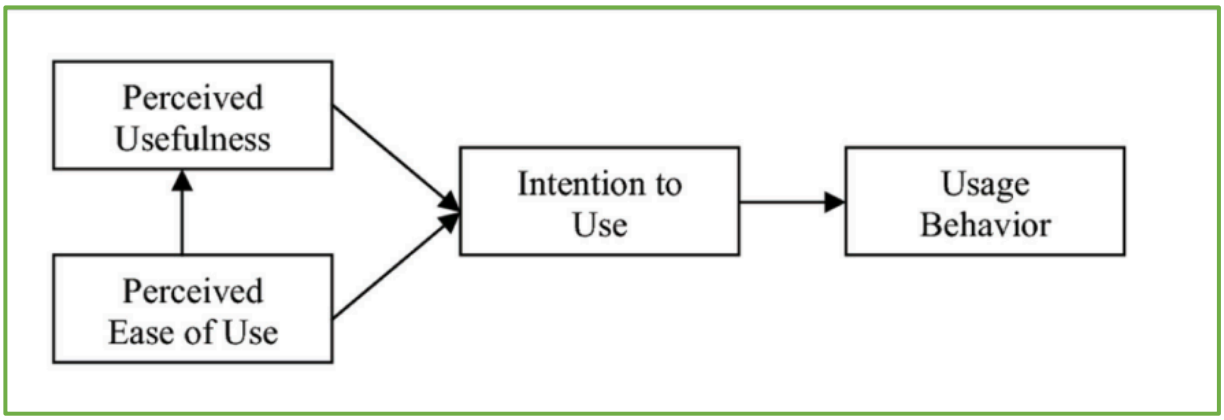



**Figure 3.7:** Technology Acceptance Model

**Source:** Davis (1989)

Figure 3.7 shows that TAM posits that two primary factors, perceived usefulness and perceived ease of use, significantly determine users' intentions towards technology adoption.

Seminal works of Davis (1989) highlight that previous research indicates that the acceptance or rejection of information technology is primarily influenced by two factors: first, the user's belief in the technology's perceived usefulness for enhancing job performance, and second, the perceived ease of use, which suggests that even a useful system may be underutilised if it is perceived as too difficult to operate. Ambrose (2024) defines Perceived usefulness (PU) as an individual's belief that using a specific technology will enhance their job performance, which significantly influences their adoption of the technology. Alfadda and Mahdi (2021) underlined that PU directly affects the intention to use technology, while perceived ease of use (PEOU) indirectly influences this intention via the user's attitude. PEOU is defined as the degree to which a person believes that using a particular piece of technology will be simple; and self-efficacy, or confidence in one's ability to use the technology successfully, supports this perception (Ambrose, 2024). In addition to the influences of perceived ease of use and usefulness, TAM suggests that the behavioural intention to adopt a system is forecasted by the user's attitude and the system's perceived usefulness, with these intentions subsequently serving as indicators of the actual system usage (Natasia, Wiranti & Parastika, 2021). TAM predicts and explains ICT use by identifying factors influencing user decisions on adopting technological innovations and enhancing ICT performance, with research confirming its insights into perceived usefulness and ease of access (Bankole, Akinadewo, Oso, Osaloni, Akinadewo, Ogungbade & Oluwadare, 2023). The fundamental aspects of TAM stay consistent across most research; however, adaptations often occur in the model's external variables or

through additional elements related to perceived usefulness and ease of use, with different researchers tailoring the model to fit specific needs, contexts, research priorities and their interpretations of TAM (Mailizar et al., 2021).

TAM is not chosen for this study because it primarily focuses on individual user acceptance and behaviour towards new technologies, whereas the transition to GICT within an organisation involves complex organisational, technological and environmental factors. TAM does not adequately address the broader organisational and external environmental challenges, such as infrastructure requirements, regulatory compliance and market dynamics, that are critical to understanding the adoption of GICT in a telecommunications company.

## 3.8 TECHNOLOGY ORGANISATION ENVIRONMENT FRAMEWORK

The Technology-Organisation-Environment (TOE) framework is a theory at the organisational level; formulated by Tornatzky and Fleischer in 1990 to evaluate how a firm's adoption of new technology is influenced by its technological capabilities, organisational structure and external environmental factors (Matikiti, Mpinganjira & Roberts-Lombard, 2018). The TOE framework endeavours to elucidate the process by which organisations or firms adopt and implement technological innovations (Adam, Alhassan & Afriyie, 2020). Mouakket and Aboelmaged (2022) highlighted that the adoption of innovations has sparked considerable interest among information systems researchers, leading to the creation of models like the TOE framework, which highlights three key dimensions that either facilitate or hinder the adoption and implementation process of innovations. Tornatzky and Fleischer (1990) introduced the TOE framework as a means to understand how innovation unfolds within a business, examining three elements—technology, organisation and environmental context—as influential factors in the adoption of innovation (Amini, 2023). Figure 3.8 illustrates the TOE framework below.

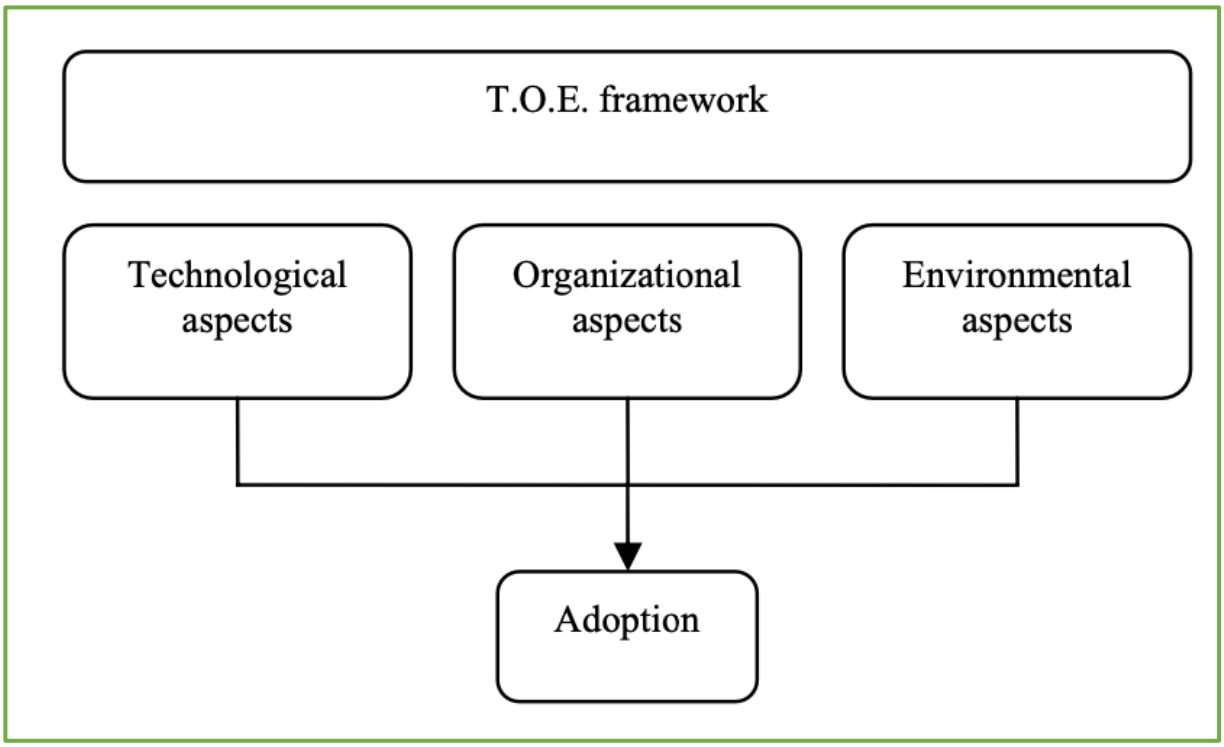



**Figure 3.8:** Technology-Organisation-Environment framework

**Source:** Tornatzky & Fleischer (1990)

Figure 3.8 offers a comprehensive model for understanding the adoption of innovations within organisations. It assesses technological, organisational and environmental factors, helping to identify barriers and enablers to GICT adoption. The technological aspect of the TOE framework focuses on the impact that the attributes of technology have on the innovation adoption process (Mouakket & Aboelmaged, 2022). The technological context comprises both internal and external technologies crucial for the organisation, encompassing equipment, processes and other pertinent technological elements essential for its operations (Adam et al., 2020). The organisational context in the TOE framework encompasses the attributes and resources of a company, such as size, structure and communication; with factors like decentralised structures favouring innovation, centralised ones aiding implementation, top management behaviour influencing adoption and the role of slack resources and company size in adoption remaining ambiguous. Each shaping the adoption and implementation of innovations in various ways (Amini, 2023). The organisational context encompasses the resources and interactions associated with innovations (Primandaru, Wulan Kusuma & Barcelona Nasution, 2023). The environmental component of the TOE framework considers industry structure, technological infrastructure and government regulations, with higher adoption rates in growing industries, and emphasises the role of skilled labour availability in

the adoption process (Amini, 2023). Collectively, these constructs, namely Technology, Organisation and Environment, shape the organisation's perspective on the necessity of adopting new technology (Adam et al., 2020).

In accordance with the TOE framework, companies achieve effective implementation of innovative practices by maintaining a harmonious balance between internal and external factors (Primandaru et al., 2023). While the TOE framework offers a valuable organisational-level lens for understanding innovation adoption, its role in this study is not as a standalone theoretical model. Instead, TOE is applied as a categorisation framework to systematically organise the variables assessed in sections B to E of the questionnaire. By mapping each item under the technological, organisational and environmental dimensions, the TOE framework complements GITAM and enhances the analytical clarity of the findings without substituting the core conceptual foundation provided by GITAM.

## 3.9 GREEN INFORMATION TECHNOLOGY ADOPTION MODEL

The Green Information Technology Adoption Model (GITAM) is a theoretical framework developed to explain and forecast the adoption of Green Information Technology (GIT) practices within organisations. The model explains that the interplay of technological, organisational and environmental contexts, along with the dynamic readiness for GIT and its primary drivers, can collectively predict the intent, scope and thoroughness of GIT adoption within an organisation (Alkali, Abdul-Azeez, Mansor, Chikaji & Dodo, 2017).

### 3.9.1 Overview of GITAM

To help organisations identify GIT metrics and align them with business processes for sustainability, the seminal work of Molla (2008) offered a comprehensive model called the GIT Adoption Model (GITAM) (Mago, 2017). GITAM characterises GIT through four interconnected perspectives, suggesting that technological, organisational and environmental context variables, dynamic GIT readiness dimensions and robust GIT drivers can forecast the intention, breadth and depth of GIT adoption (Molla, 2008). GITAM by Molla (2008) asserts that an organisation's inclination and subsequent adoption of GIT are determined by variables like GIT readiness, GIT context and GIT drivers (Thomson & Van Belle, 2015). GITAM suggests that a combination of static contextual variables, dynamic readiness constructs and

drivers of GIT can collectively forecast an organisation's intention to adopt GIT practices (Alkali et al., 2017).

Seminal works by Molla (2008) highlighted that businesses are increasingly integrating GIT to improve environmental sustainability and cost efficiency; however, actual benefits are uncertain without adoption into operations, which the GITAM seeks to systematise by assessing technological, organisational and environmental factors alongside readiness and drivers for comprehensive implementation. The core premise of the model is that by analysing a set of unchanging GIT contextual elements, evolving dimensions of readiness for GIT and key motivating factors, one can forecast an organisation's intent to adopt GIT and account for much of the differences in how GIT is actually adopted and practiced (Molla, 2008). Despite the appealing prospects of GIT, the actual extent of its adoption and the realisation of its anticipated benefits remain uncertain, leading to the development of the GITAM by Molla; which defines GIT through four interconnected perspectives and suggests that a combination of technological, organisational and environmental contexts, alongside dynamic readiness and strong drivers, can forecast both the intention and the comprehensive adoption of GIT in terms of its breadth and depth (Mago, 2016).

The GITAM framework integrates the Technology-Organisation-Environment (TOE) model to pinpoint static primary contexts for GIT, termed 'GIT Context', and the Perceptual Readiness Model (PERM) to capture dynamic, perception-based readiness, referred to as 'GIT Readiness'. Beyond these, the model suggests that strong-order reasons, or drivers, also significantly influence the content and process of GIT adoption (Molla, 2008). The GITAM model is designed to help organisations assess their readiness for GIT, understand the drivers and barriers to GIT adoption and implement strategies to enhance their environmental sustainability through IT. Below, Figure 3.9 displays the GITAM model.

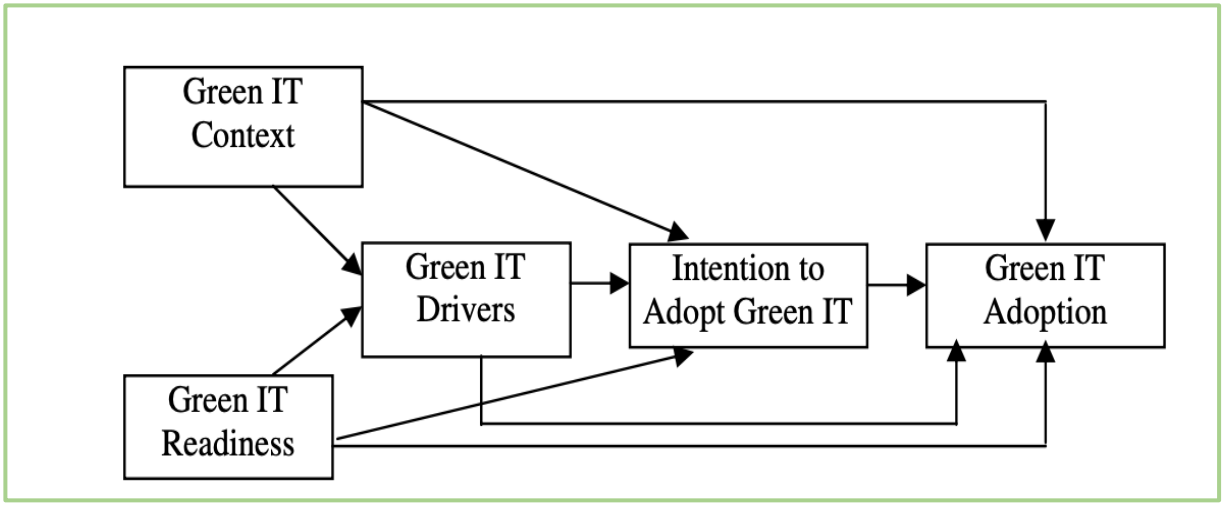



**Figure 3.9:** Green Information Technology Acceptance Model

**Source:** Molla (2008)

According to Mago (2016), GITAM consists of four constructs towards GIT adoption. These are GIT readiness, GIT context and various GIT drivers, all of which influence both an organisation's intention to adopt GIT and the actual implementation of such practices. GIT is conceptualised through four interconnected perspectives: sourcing, which focuses on eco-friendly IT procurement; operations, aimed at enhancing energy efficiency and reducing greenhouse gases from IT equipment; services, where IT supports overall business sustainability via tools for green supply chain and carbon footprint analysis and end-of-life management, which encompasses the reuse, recycling and disposal of IT hardware (Molla, 2008).

The four constructs of GITAM are discussed below and, based on the reviewed literature of GITAM, a set of hypotheses is posed. These hypotheses will be used in the compilation of the research instrument and it is envisaged that they will assist in solving the research problem, answering the research questions and achieving the study's objectives.

### 3.9.2 Construct 1: Green information technology context

Molla (2008) explains that the context for GIT adoption is shaped by technological factors, where organisations with substantial IT infrastructure may adopt GIT due to the pressures of electricity costs and the demands of maintaining high-density servers; organisational factors, where businesses' sectors and sizes influence their GICT adoption, with utility companies and

information-intensive sectors like data storage, finance and telecom expected to be early adopters; and environmental factors within the TOE framework, where regulatory environments created by governments and intergovernmental organisations encourage GIT through legislation supporting a low-carbon economy. The GIT context refers to the key inherent attributes of the adoption setting that can be appraised in a relatively objective manner (Mago, 2016). The GIT context within the GITAM framework evaluates current characteristics of technology adoption models and categorises them into three contexts—technological, organisational and environmental—based on the TOE model (Thomson & Van Belle, 2015). Hejri, Radfar, Zohrabi and Rabieipakdeh, (2022) outline that the GIT context within the GITAM framework is categorised into the following three areas:

- Technological, characterised by substantial IT infrastructure and high-power costs.
- Organisational, influenced by size, sector and corporate citizenship.
- Environmental, shaped by regulatory settings promoting a low-carbon economy.

Table 3.1 outlines the contextual factors that influence the adoption of GICT. This includes technological factors, which consider the financial motivations, strategic and operational excellence existing and regulation, risk and compliance; organisational factors, which examine the organisational identity, culture and talent; stakeholder engagement and partnership and environmental factors, which are shaped by sustainability, global dynamics and social responsibility. These elements are critical in understanding how the context within which Organisation A operates impacts its adoption of GICT. The table provides a detailed description of each factor along with corresponding hypotheses to test their influence on the adoption of GICT.

**Table 3.1: Construct 1: Green information technology context**

| **Construct 1: Green information technology context** | | |
|---|---|---|
| **Contextual factor** | **Description** | **Hypothesis** |
| | **Technological factor** | |
| Financial Motivations | Chapter 2 highlights the financial savings and cost efficiencies that GICT technologies can bring (§2.4.2.1). | Hypothesis H1: The current state of Green ICT adoption in Organisation A is suboptimal. |
| Strategic and Operational Excellence | Chapter 2 shows GICT can enhance operational performance and strategic benefits (§2.4.2.2). | |
| Regulation, Risk and Compliance | Chapter 2 highlights compliance and risk management benefits associated with GICT solutions, | |

| Construct 1: Green information technology context | | |
|---|---|---|
| **Contextual factor** | **Description** | **Hypothesis** |
| | **Technological factor** | |
| | including regulatory requirements that impact adoption (§2.4.2.3). | |
| | **Organisational factor** | |
| Organisational Identity, Culture and Talent | Chapter 2 discusses how the alignment of GICT initiatives with an organisation's identity, culture and talent can drive adoption (§2.4.2.4). | |
| Stakeholder Engagement and Partnership | Chapter 2 highlights the importance of stakeholder engagement and partnerships in driving GICT adoption (§2.4.2.5). | |
| | **Environmental factor** | |
| Sustainability, Global Dynamics and Social Responsibility | Chapter 2 discusses the sustainability, global dynamics and social responsibility benefits of GICT, which act as drivers for its adoption (§2.4.2.6). | |

**Source:** Author's Compilation (2024)

### 3.9.3 Construct 2: Green information technology readiness

Molla (2008) conveys that GIT readiness is an evolving measure of an organisation as well as its environment's preparedness for GIT, encompassing a firm's internal awareness, commitment and resources; the readiness of its value network, including suppliers marketing green solutions and the perceived dedication of formal institutions like governments and professional associations, as well as informal norms, to support GIT initiatives and renewable energy development. Mago (2016) explains that GIT readiness encompasses the organisation's own perception of its readiness, the preparedness of its value network and the perceived commitment of institutions towards GIT initiatives. GIT readiness is a dynamic assessment of an organisation as well as its environment's readiness to adopt GIT, including organisational commitment, resources and awareness; as well as the preparedness of its value network, such as suppliers, consumers, investors and rivals and the influence of governments and professional institutions through subsidies, norm-setting and professional practices that can all impact the initiation and adoption of GIT (Hejri et al., 2022).

Table 3.2 outlines the readiness factors impacting the readiness of an organisation to adopt GICT. This construct examines cultural and social challenges, knowledge and communication

challenges, market and demand challenges, readiness challenges, organisational and strategic barriers, financial barriers, policy and regulatory barriers as well as external and internal physical barriers that influence GICT adoption. The table provides detailed descriptions and associated hypotheses to comprehensively evaluate these factors within Organisation A.

**Table 3.2: Construct 2: Green information technology readiness**

| Construct 2: Green information technology readiness | | |
|---|---|---|
| **Readiness factor** | **Description** | **Hypothesis** |
| Cultural and Social Challenges | Table 2.1 of Chapter 2 highlights how organisations and stakeholders' culture, along with employee resistance to change, impact the adoption of GICT (§Table 2.1). | Hypothesis H2: There are significant challenges and barriers effecting Organisation A's transition to Green ICT. |
| Knowledge and Communication Challenges | Table 2.1 of Chapter 2 highlights the need for effective communication and training programmes to enhance employee awareness and knowledge about GICT (§Table 2.1). | |
| Market and Demand Challenges | Table 2.1 of Chapter 2 highlights how external market demand influences the adoption of GICT solutions within organisations (§Table 2.1). | |
| Readiness Challenges | Table 2.1 of Chapter 2 highlights various readiness challenges for GICT adoption in the telecommunications industry (§Table 2.1). | |
| Organisational and Strategic Barriers | Table 2.2 of Chapter 2 discusses barriers related to strategic alignment, management support and organisational culture (§Table 2.2). | |
| Technical and Infrastructure Barriers | Table 2.2 of Chapter 2 discusses the technical barriers and infrastructure requirements necessary for implementing GICT solutions (§Table 2.2). | |
| Financial Barriers | Table 2.2 of Chapter 2 discusses financial challenges, such as high costs and a lack of funding, that can hinder the adoption of GICT (§Table 2.2). | |
| Policy and Regulatory Barriers | Table 2.2 of Chapter 2 discusses external regulatory and policy-related challenges that impact the adoption of GICT solutions (§Table 2.2). | |
| External and Physical Barriers | Table 2.2 of Chapter 2 discusses challenges related to the external environment and physical constraints that affect the adoption of GICT (§Table 2.2). | |

**Source:** Author's Compilation (2024)

### 3.9.4 Construct 3: Drivers of Green information technology

GITAM identifies certain factors known as GIT enablers or drivers that can affect how GIT is adopted within an organisation (Cordero, Altamirano, Parra & Espinoza, 2023). Molla (2008)

describes three primary drivers of GIT: economic, emphasising cost savings and efficiency; regulatory, motivated by legislation and often leading to a minimalist GIT strategy and ethical, focusing on socially responsible practices. Each of these influencing the nature and implementation of GIT initiatives differently, depending on a business's specific context, technological capability, organisational support and environmental circumstances, as well as its readiness to adopt GIT; with more prepared businesses likely to embrace GIT for economic and ethical reasons, while others may be pressured by external regulatory requirements. GIT drivers encompass economic aspects focusing on IT efficiency and cost savings, regulatory factors that are pivotal for organisational adoption, which could lead to a minimalistic adoption strategy emphasising practices like environmentally preferred procurement and carbon footprint assessment and ethical drivers that represent the commitment to social responsibility and corporate citizenship (Hejri et al., 2022).

Table 3.3 outlines the driving factors impacting an organisation's adoption of GICT. This construct examines financial motivations; strategic and operational excellence; regulation, risk and compliance; organisational identity, culture and talent; stakeholder engagement and partnership as well as sustainability, global dynamics and social responsibility, that influence GICT adoption. The table provides detailed descriptions and associated hypotheses to comprehensively evaluate these factors within Organisation A.

**Table 3.3: Construct 3: Drivers of Green information technology**

| **Construct 3: Drivers of Green information technology** | | |
|---|---|---|
| **Driving factor** | **Description** | **Hypothesis** |
| Financial Motivations | Chapter 2 discusses financial motivations and highlights the cost savings and efficiencies that Green ICT technologies can bring (§2.4.2.1). | Hypothesis H3: A higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A. |
| Strategic and Operational Excellence | In Chapter 2, strategic and operational excellence discusses how GICT can enhance operational performance and strategic benefits (§2.4.2.2). | |
| Regulation, Risk and Compliance | Chapter 2 discusses regulation, risk and compliance and covers the compliance and risk management benefits associated with GICT solutions, including regulatory requirements (§2.4.2.3). | |
| Organisational Identity, Culture and Talent | In Chapter 2, organisational identity, culture and talent highlight how the alignment of GICT initiatives with an organisation's identity, culture and talent can drive adoption (§2.4.2.4). | |

| Construct 3: Drivers of Green information technology | | |
|---|---|---|
| **Driving factor** | **Description** | **Hypothesis** |
| Stakeholder Engagement and Partnership | In Chapter 2, stakeholder engagement and partnership discuss the importance of stakeholder engagement and partnerships in driving GICT adoption (§2.4.2.5). | |
| Sustainability, Global Dynamics and Social Responsibility | In Chapter 2, sustainability, global dynamics and social responsibility highlight the sustainability benefits, global dynamics and social responsibility benefits of Green ICT (§2.4.2.6). | |

**Source:** Author's Compilation (2024)

### 3.9.5 Construct 4: Intention to adopt Green ICT

Molla (2008) identifies a discrepancy between the awareness of GIT principles and their actual implementation in businesses, suggesting a need to investigate the specific factors that could transform intentions into actions, and introduces two metrics: breadth, which assesses the extent of GIT practices across different areas of IT operations and depth, which measures the level of GIT integration within a specific domain, such as sourcing, to provide a detailed understanding of GIT adoption levels in businesses.

Table 3.4 outlines the intention factors impacting an organisation to adopt GICT. This construct examines commitment and plans, motivations and strategic plans as well as industry strategies and goals that influence GICT adoption. The table provides detailed descriptions and associated hypotheses to comprehensively evaluate these factors within Organisation A.

**Table 3.4: Construct 4: Intention to adopt Green ICT**

| Construct 4: Intention to adopt Green ICT | | |
|---|---|---|
| **Intention factor** | **Description** | **Hypothesis** |
| Commitment and Plans | In Chapter 2, Organisation A's intention to adopt GICT reflects their commitment and plans to implement GICT practices and technologies (§6.2.1). | N/A |
| Motivations and Strategic Plans | Chapter 2 discusses the motivations and strategic plans for adopting GICT (§2.4.2) and (§2.4.5). | |
| Industry Strategies and Goals | Table 2.3 of Chapter 2 highlights the GICT strategies and goals of prominent telecommunications organisations, showcasing industry commitment and | |

| Construct 4: Intention to adopt Green ICT | | |
|---|---|---|
| **Intention factor** | **Description** | **Hypothesis** |
| | practical steps to achieve environmental sustainability (§Table 2.3). | |

**Source:** Author's Compilation (2024)

### 3.9.6 Adoption of Green ICT

The adoption of GIT is primarily driven by economic, regulatory and ethical factors and, while these motivators are not exclusive to each other, the dominance of one can significantly steer the implementation and preference for particular GIT strategies within an organisation (Mago, 2016).

Table 3.5 outlines the adoption factors impacting an organisation to adopt GICT. This examines the practical implementation of GICT practices and technologies and the economic, regulatory and ethical factors that influence GICT adoption. The table provides detailed descriptions and associated hypotheses to comprehensively evaluate these factors within Organisation A.

**Table 3.5: Adoption of Green ICT**

| Adoption of Green ICT | | |
|---|---|---|
| **Adoption factor** | **Description** | **Hypothesis** |
| Practical Implementation of GICT Practices and Technologies | The adoption of Green IT involves the practical implementation of GICT practices and technologies within an organisation. Sections (§2.4.4) and (§2.5.6) of the Chapter 2 literature review discuss the specific practices, strategies and outcomes of GICT adoption. | N/A |
| Economic, Regulatory and Ethical Factors | GICT adoption is influenced by economic benefits, regulatory pressures and ethical considerations. Sections (§2.4.2.3), (§2.4.2.6) and (§2.4.2.1) of Chapter 2 highlight how economic benefits, regulatory frameworks and ethical commitments to sustainability impact the adoption of GICT practices. | |

**Source:** Author's Compilation (2024)

### 3.9.7 Motivation for selecting GITAM for this study

The correct application and sequence of underpinning theories are crucial in research to ensure a study is conducted with rigour; guiding the researcher from data collection to analysis and making the study holistic while maintaining a balance between rigour and relevance, which is particularly important in information systems for establishing a study's consistency, cohesion, credibility and solidity (Iyamu, 2013). Seminal works of Molla (2008) introduce GITAM for exploring GIT adoption, highlighting three main contributions: it is a pioneering effort to establish GIT as a research domain amidst growing ecological concerns within the IT sector; it offers a detailed conceptualisation of GIT from four distinct perspectives requiring clarity in research definitions to ensure comparability between studies and it delineates both secondary facilitators and primary drivers of GIT, providing a robust theoretical and empirical foundation for future research. GITAM provides a structured framework for understanding and advancing the adoption of sustainable IT practices. Organisations can use it to evaluate their intention to adopt GIT solutions, identify drivers and assess their readiness before implementing them. This helps lessen their environmental impact and may also result in cost savings and improved competitive positioning. GITAM is highly suitable for this study of Organisation A due to its specific focus on GICT adoption. Unlike general models, GITAM addresses the unique challenges and drivers of GICT, providing relevant insights. It considers technological, organisational and environmental factors, providing a comprehensive framework for analysis. GITAM emphasises organisational intention and readiness, aligning with the study's goals to assess and improve GICT adoption within Organisation A. The model's empirical support and practical relevance offer actionable insights, making it an ideal choice to guide this research.

## 3.10 CONCLUSION

This chapter has carefully examined a number of underpinning theories that illuminate the multifaceted nature of technology adoption, each offering valuable insights into the determinants and dynamics of embracing new technologies.

A comparative analysis has been conducted on several foundational theories related to technology adoption, including the theory of reasoned action, the theory of planned behaviour, the diffusion of innovation theory, the unified theory of acceptance and use of technology, the green readiness framework, the technology acceptance model, the technology-organisation-environment framework and the green information technology adoption model. These theories

have been systematically examined to assess their relevance and efficacy in addressing the intricacies of technology adoption.

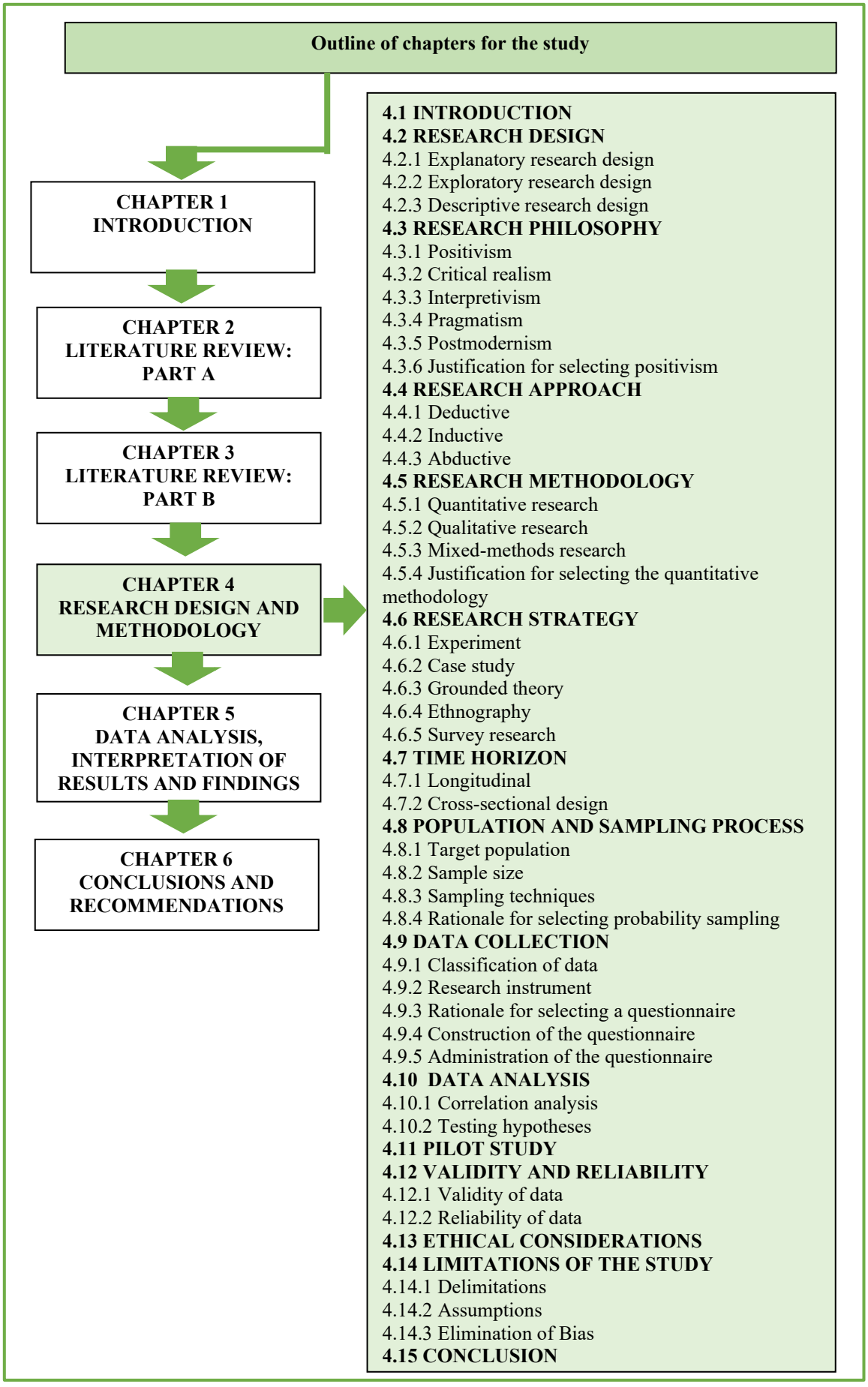
After a thorough evaluation GITAM was chosen due to its specific focus on GICT adoption, encompassing critical factors like technology, organisation, environment, readiness, drivers and intentions to adopt GICT. GITAM provides a comprehensive framework that integrates various dimensions crucial for understanding the adoption of GICT within Organisation A. Although GITAM serves as the primary theoretical framework, the TOE framework is used in this study as a complementary classification tool. It supports the analysis by organising key variables across technological, organisational and environmental dimensions within the questionnaire (sections B to E), enhancing the clarity and structure of the empirical investigation. Overall, GITAM's comprehensive approach, supplemented by the TOE framework's categorisation structure, makes it the most suitable foundation for analysing the transition to GICT within Organisation A.

In Chapter 4 the research methodology utilised in this study is outlined, detailing the methodological choices, methods and procedures used to evaluate the transition of a South African telecommunications company to GICT.

# CHAPTER 4
# RESEARCH DESIGN AND METHODOLOGY

## 4.1 INTRODUCTION

In Chapter 3, Literature Review: Part B, several underpinning theories were explored to understand the adoption of GICT within an organisation. After thorough analysis, the GITAM was chosen as the most suitable underpinning theory. The choice of research design and methodology is crucial in addressing the research objectives and ensuring the validity and reliability of the findings. This chapter details the research design and methodology for studying the adoption of GICT within Organisation A. It comprises the research philosophy, approach and rationale for using quantitative methods. Various research designs and strategies are discussed, including explanatory, exploratory, descriptive, experimental, case studies, grounded theory, ethnography and surveys. The time horizon, population and sampling processes and data collection methods are explained, highlighting the use of questionnaires. Additionally, data analysis methods, pilot study, validity, reliability, ethical considerations, limitations, delimitations, assumptions and bias elimination measures are outlined. Figure 4.1 presents the structure of this chapter.


Outline of chapters for the study
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RESEARCH DESIGN AND
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**Figure 4.1**: Outline of Chapter 4
**Source:** Author's compilation (2024)

## 4.2 RESEARCH DESIGN

Research design is the blueprint for a study, directing the collection and analysis of data and serving as a roadmap for the research process (Pandey & Pandey, 2015). A research design defines a detailed roadmap for the researcher's planned steps to meet the study's goals and offers a guiding framework for executing the research (Saunders, Lewis, Thornhill, Lewis & Thornhill, 2019). Social research serves multiple purposes, with exploration, description and explanation being among the most common and valuable (Babbie, 2016). These three research designs are discussed below.

### 4.2.1 Explanatory research design

Explanatory research aims to determine causal relationships between variables, focusing on examining a situation or problem to explain these relationships (Saunders et al., 2019). In explanatory research, causal relationships between a determinant and an event are examined, considering confounders and modifiers, with conflicting results often due to differences in theoretical design or mismatches between theoretical design and data collection methods (Bentouhami, Casas & Weyler, 2021).

### 4.2.2 Exploratory research design

Exploratory research is particularly valuable for clarifying the nature of a problem, helping to determine if further research is warranted or if the issue is not worth pursuing (Saunders et al., 2019). This approach is usually employed when a researcher investigates a new area of interest or when the subject under study is relatively novel (Babbie, 2016). Exploratory research, also known as formulative research, aims to formulate problems for precise investigation and develop working hypotheses, emphasising idea discovery and requiring flexible research design to explore different problem aspects (Kothari & Garg, 2019).

### 4.2.3 Descriptive research design

Descriptive research design is used to collect information on specific phenomena or characteristics within a sample or population in their natural environment (Bloomfield & Fisher, 2019). Many social science studies aim to accurately and precisely describe situations and events through careful and deliberate observation, resulting in scientific descriptions that are more reliable and detailed compared to casual observations (Babbie, 2016). A descriptive quantitative study aims to methodically quantify, depict and interpret variables in a specific sample; typically collecting information about a certain phenomenon or characteristic within that population in its natural context (Bloomfield & Fisher, 2019).

This research used a descriptive research design, which involved identifying the characteristics of an observed phenomenon or exploring possible correlations between two or more phenomena. The researcher explored correlations between various factors and the perceived challenges in the transition to GICT. Descriptive research was suitable for this study as it allowed for a thorough and systematic examination of the current state of GICT adoption, identified the challenges and barriers faced, and provided a comprehensive understanding of the organisational context. This approach ensured that the research objectives were effectively addressed and that the findings were relevant and actionable for the organisation's transition to GICT.

The research onion framework outlines the several decisions a researcher will make when formulating the research methodology (Saunders et al., 2019). Figure 4.2 depicts the Saunders Research Onion which consists of six layers. The next section discusses the research philosophy of the study.

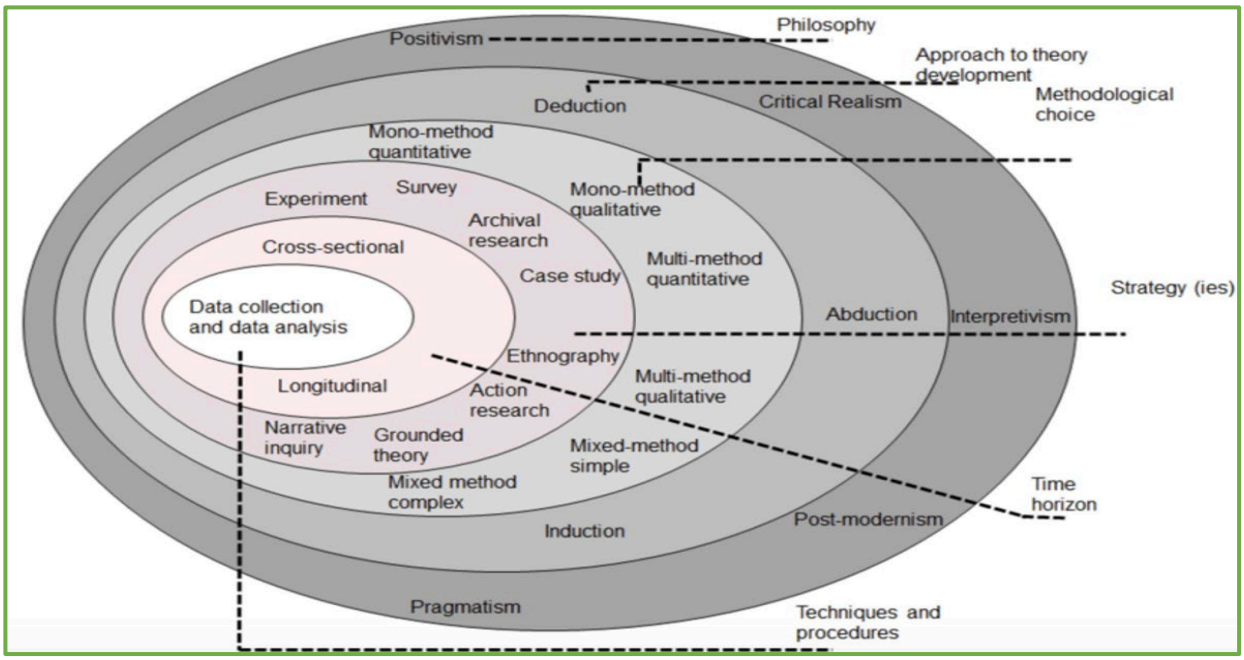


**Figure 4.2:** Saunders Research Onion

**Source:** Saunders et al. (2019)

## 4.3 RESEARCH PHILOSOPHY

Research philosophy is defined as the gathering of beliefs and assumptions about the formation and progression of knowledge (Saunders et al., 2019). During the research process, three kinds of assumptions are either knowingly or unknowingly made: ontological, epistemological and axiological assumptions (Saunders et al., 2019).

- *Ontology:* This is the study of reality. In business and management research principally revolves around two perspectives: objectivism, which argues that social entities exist independently of individuals and subjectivism, which proposes that social phenomena stem from individual perceptions and actions (Saunders et al., 2019). Ontology is crucial to conservation science as it helps researchers assess the certainty of their understanding regarding the nature or existence of the objects they study, determine the legitimacy of truth claims and navigate differing perspectives on reality (Moon & Blackman, 2014). Ontology deals with understanding the nature and essence of existence, specifically focusing on the characteristics and reality of a particular phenomenon (Junjie & Yingxin, 2022).
- *Epistemology:* Epistemology's relevance to conservation science lies in its bearing on researchers' approaches to knowledge acquisition and the framing of research, encompassing the validity of claims, methods of acquiring knowledge and determining

its applicability (Moon & Blackman, 2014). Epistemology involves what constitutes acceptable knowledge in a field of study (Saunders et al., 2019). Epistemology addresses the validity, scope and methods of acquiring knowledge, focusing on what constitutes a knowledge claim, how knowledge is produced or acquired and determining its applicability (Junjie & Yingxin, 2022).

- *Axiology*: The researcher assesses the relevance and significance of values within the research framework (Saunders et al., 2019). Axiology explains the doctrine of value, or the good, as one of the two main branches of ethical theory, alongside the theory of the right (Shokhin, 2020). Axiology is the philosophical study of norms and values, including concepts like good and bad, fair or unfair and right or wrong, as they relate to everyday life (Rosida, Amaliah, Mahardika & Suratno, 2023).

Saunders et al. (2019) outline five major philosophies in business management. These are positivism, critical realism, interpretivism, postmodernism and pragmatism. Below, the five philosophical approaches within business and management research are discussed.

### 4.3.1 Positivism

Positivism, a philosophical viewpoint common among natural scientists, involves analysing observable social reality with the potential to formulate generalisations akin to laws observed in the physical and natural sciences (Saunders et al., 2019). Positivism emphasises objectivity, disregarding the significance of subjective experiences and values of both research participants and researchers; necessitating the researcher's non-interaction with participants during data collection and minimal involvement in the experiment, a requirement that can be straightforwardly applied in certain fields (Park, Konge & Artino, 2020). This study is anchored in positivism and based on epistemological assumptions. Positivism is a philosophical framework that relies on rational verification or falsification of scientific statements and assumes the existence of a discernible, objective reality (Babbie, 2016).

### 4.3.2 Critical realism

Critical realism suggests defining "reality" as that which has observable effects, thus considering prejudice as "real" due to its clear impact on our lives (Babbie, 2016). Critical realism adopts a postpositivist stance, acknowledging that the social world exists with its own

realities and mechanisms, which may be independent of our awareness and can be obscured or inactive, making them not always directly observable (Ellaway, Kehoe & Illing, 2020). The approach of critical realism research aims to investigate and modify the properties and mechanisms of phenomena to mitigate negative impacts and promote positive outcomes, fundamentally centred on actionable strategies to advance human rights (Haigh, Kemp, Bazeley & Haigh, 2019).

### 4.3.3 Interpretivism

Interpretivism stresses the importance of researchers understanding human differences as social actors, comparing research among people to theatrical productions where individuals interpret and act out their social roles based on personal or directed meanings while also interpreting others' roles through their own perspectives (Saunders et al., 2019). Interpretivism emerged as a critique of positivism, focusing on subjective perspectives and emphasising that humans, with their complex meanings and in-depth contextual factors, cannot be studied in the same way as physical phenomena (Alharahsheh & Pius, 2020). Junjie and Yingxin (2022) argue that, unlike natural phenomena, human beings possess the unique ability to create depth in meaning, making it more complex to generalise social reality than positivism attempts to do.

### 4.3.4 Pragmatism

Pragmatism asserts that the research question is the key determinant of the adopted epistemology, ontology and axiology; allowing for flexibility and the use of various philosophical approaches depending on the specific question (Saunders et al., 2019). Pragmatism views knowledge as a spectrum where both observable and unobservable elements are recognised based on the researcher's current perspective, merging qualitative and quantitative research views (Maarouf, 2019). As a worldview or philosophy, pragmatism arises from actions, situations and consequences rather than prior conditions; with a focus on practical applications, solving problems and prioritising the research problem over specific methods, using all available approaches to achieve understanding (Creswell & Creswell, 2018).

### 4.3.5 Postmodernism

A paradigm that challenges the assumptions of positivism and theories that describe an "objective" reality (Babbie, 2016). Postmodernism challenges the concepts of causality, objectivity, egalitarianism, rationality and the notion of absolute truth (Moon & Blackman, 2014). Stewart, St. Pierre, Devine and Kirloskar-Steinbach (2021) argues postmodernism challenges the traditional belief in science and technology as solutions to all human problems, highlighting how these assumptions, deeply rooted in Western capitalist ideologies, have been supported by oppressive frameworks and urging researchers to reconsider overlooked aspects of science within qualitative inquiry.

### 4.3.6 Justification for selecting positivism

Researchers must first consider their philosophical worldview assumptions, align them with an appropriate research design and then apply specific methods or procedures to practically implement the study (Creswell & Creswell, 2018). Positivism is utilised in this study because it aligns with the research's quantitative approach and the goal of obtaining precise, reliable data through statistical analysis. The study employed quantitative methods, including a structured online questionnaire and the use of the Stata statistical package (Stata version 19), which were consistent with positivist principles that stress objectivity, measurement and hypothesis testing through deductive reasoning. Additionally, positivism supported the establishment of cause-and-effect relationships, which was essential for identifying the challenges and barriers to the adoption of Green ICT in a telecommunications organisation. By applying a positivist perspective, this study aimed to generate generalisable findings that enhanced the understanding of Green ICT implementation and informed strategic decision-making within the organisation. The study sought to objectively quantify and assess the difficulties associated with the transition to Green ICT, treating these challenges as objective realities that could be researched in an unbiased and empirical manner.

## 4.4 RESEARCH APPROACH

A research project's approach to theory, often not explicit in its design but clear in its findings, focuses on testing or constructing theories and often revolves around choosing deductive, inductive or abductive reasoning to guide its design (Saunders et al., 2019). Below, deductive, inductive and abductive approaches will be discussed.

### 4.4.1 Deductive

Deductive research originates from theory, formulating hypotheses tested through observations, while inductive research starts with observations, seeking patterns within the observed data (Babbie, 2016). A deductive approach is applied when research initiated with a theory, commonly grounded in scholarly literature, and proceeds with a methodical plan to test that theory (Saunders et al., 2019). Deductive approaches involve beginning with theories or models to test their implications and to establish feasible models; while synthesising existing literature findings can lead to the creation of new theories (Zeithaml, Jaworski, Kohli, Tuli, Ulaga & Zaltman, 2020). Deductive reasoning, rooted in scientific inquiry, involves creating and testing a theory with propositions and is a mainstay in the natural sciences for explaining, predicting and controlling phenomena based on established laws (Saunders et al., 2019).

### 4.4.2 Inductive

An inductive approach is employed when the research commences with the collection of data to investigate a phenomenon and seeks to formulate or construct a theory, like a conceptual framework (Saunders et al., 2019). Inductive research methods start by collecting data to delve into phenomena, aiming to discover new theoretical insights, particularly when researchers identify gaps in existing literature and use their own experiences to formulate fresh theories (Zeithaml et al., 2020).

### 4.4.3 Abductive

An abductive approach is adopted when research involves collecting data to examine a phenomenon, pinpoint themes and clarify patterns for the purpose of generating or refining a theory, which is subsequently validated with additional data gathering (Saunders et al., 2019). Abductive theory construction shifts the focus towards the generation of new, original theories by interpreting data through the lens of meaningful environmental differences, without the constraints of existing theoretical frameworks or the aim of confirmatory hypothesis testing (Janiszewski & Van Osselaer, 2022).

The study utilised a deductive approach because a specific theory was utilised, in this case GITAM, which was validated within the context of a telecommunications company in South

Africa. The hypotheses provided by GITAM were tested against empirical data from the company to determine whether the theoretical assertions held true in this particular real-world scenario. This method was deductive because it worked from a general theory down to specific instances, allowing the researcher to draw conclusions about the applicability and reliability of GITAM in the context of ICT challenges within the South African telecommunications industry.

The following section examines the research method.

## 4.5 RESEARCH METHODOLOGY

Research methodology offers the theoretical and philosophical framework for conducting studies, which can be quantitative, qualitative or mixed methods in nature (Saunders et al., 2019). Worldviews, designs and methods all contribute to shaping a research approach, which can be quantitative, qualitative or mixed (Creswell & Creswell, 2018). These three methods will be discussed below.

### 4.5.1 Quantitative research

Quantitative usually refers to methods, like questionnaires; or analysis procedures, such as graphing or statistical evaluations, that produce or involve numerical data (Saunders et al., 2019). Quantitative research entails testing theories by examining relationships between variables that are measurable and yield numerical data for statistical analysis (Creswell & Creswell, 2018).

### 4.5.2 Qualitative research

Qualitative methods, such as interviews or data categorisation, predominantly deal with non-numerical data, covering both textual and visual content like images and videos (Saunders et al., 2019). Qualitative research inquires to understand the interpretations individuals or groups give to specific human or societal issues, evolving its inquiries, collecting context-specific data and moving from detailed observations to broader thematic interpretations by the researcher (Creswell & Creswell, 2018).

### 4.5.3 Mixed-methods research

Mixed-methods research incorporates quantitative and qualitative methods, allowing for the conversion of data into narratives or numerical codes, facilitating both qualitative analysis and statistical evaluation (Saunders et al., 2019). Mixed-methods research, based on potential philosophical and theoretical bases, posits that integrating quantitative and qualitative data yields insights beyond those obtained from either source individually (Creswell & Creswell, 2018).

### 4.5.4 Justification for selecting the quantitative methodology

Quantitative research tests objective theories by examining measurable variable relationships, using numerical data for statistical analysis and following a structured report format while ensuring bias protection, control of alternative explanations and generalisability of findings (Creswell & Creswell, 2018). A quantitative approach offers a structured, objective and measurable perspective on the challenges of transitioning to GICT, delivering insights that can drive informed decisions and interventions. Quantitative research commonly assesses a hypothesis, frequently the null hypothesis, by selecting a representative sample from a specific population, measuring variables and using statistical analyses to validate these measures (Bloomfield & Fisher, 2019). This research used a quantitative method to investigate the challenges that a SA telecommunications organisation encounters when transitioning to GICT. In a quantitative study, correlations or relationships between variables can be investigated (Babbie, 2016). Through this approach, the researcher was able to determine the relationship between the challenges that Organisation A faced during its transition to GICT and the success of implementing GICT practices.

## 4.6 RESEARCH STRATEGY

A research strategy is a general plan outlining how the researcher will approach answering the research question (Saunders et al., 2019). Research strategies, including experiments, case studies, grounded theory, ethnography and surveys, will be discussed below.

### 4.6.1 Experiment

The experimental approach involves manipulating variables to observe their effects in a controlled environment, while the simulation approach creates an artificial environment to generate data and observe system dynamics under controlled conditions (Kothari & Garg, 2019). Experimental research focuses on cause and effect by identifying dependent and independent variables and determining the impact of changes in the independent variables on the dependent variable (Igwenagu, 2016).

### 4.6.2 Case study

The case study method involves in-depth qualitative analysis of a social unit, focusing on the processes and interrelationships to identify factors explaining behavioural patterns (Kothari & Garg, 2019). A case study attempts to describe relationships that exist in reality (Igwenagu, 2016).

### 4.6.3 Grounded theory

In grounded theory, data collection begins without a preset theoretical framework, allowing theory to emerge from observations that generate predictions, which are subsequently tested through further observation (Saunders et al., 2019). Grounded theory involves deriving theories from analysing patterns, themes and common categories identified in observational data (Babbie, 2016).

### 4.6.4 Ethnography

Ethnography, rooted in an inductive approach from anthropology, aims to describe and explain the social world of research subjects as they themselves would describe and explain it (Saunders et al., 2019). Ethnography is an inquiry design from anthropology and sociology where the researcher studies the shared behaviours, language and actions of a cultural group in a natural setting over an extended period, often using observations and interviews (Creswell & Creswell, 2018).

### 4.6.5 Survey research

Survey research provides a numerical depiction of patterns, attitudes or views of a population by examining a subset of that group (Creswell & Creswell, 2018). Usually used in a deductive approach, the survey strategy in business and management research efficiently gathers extensive data from a large population, answering questions like who, what, where, how much and how many, making it ideal for exploratory and descriptive research (Saunders et al., 2019).

This study utilised the survey method with a questionnaire, which involves collecting standardised data from selected employees within Organisation A. This method is notably useful for descriptive research that seeks to measure attitudes, opinions, behaviours or other defined variables, aiming to project these findings from a subset to the overall population.

## 4.7 TIME HORIZON

The Time Horizon refers to the timeframe over which the data is collected. These are longitudinal and cross-sectional, which are discussed below.

### 4.7.1 Longitudinal

A longitudinal study is a research design that involves collecting data at multiple points in time to observe the same phenomenon over an extended period of time (Babbie, 2016). Longitudinal studies involve collecting data over an extended period of time (Creswell & Creswell, 2018).

### 4.7.2 Cross-sectional design

The "snapshot" time horizon, known as a cross-sectional design, takes a specific moment to describe a phenomenon or examine relationships between factors across different organisations (Saunders et al., 2019). A cross-sectional study entails making observations of a sample or cross-section of a population or phenomenon at a single point in time (Babbie, 2016).

The research uses a cross-sectional time horizon, examining the challenges existing at a particular moment in time. A structured questionnaire has specific questions, designed for clear comprehension, with responses that can be aggregated for statistical analysis (Nayak & Singh, 2015). Data collection in this research involved the administration of a structured questionnaire

to employees and relevant stakeholders, aimed at gathering their perceptions of the challenges associated with transitioning to Green ICT in Organisation A.

## 4.8 POPULATION AND SAMPLING PROCESS

### 4.8.1 Target population

The population in a study refers to the group, generally consisting of individuals, from which the researchers aim to derive conclusions (Babbie, 2016). The population is the complete set of cases from which a researcher chooses a sample for their study (Taherdoost, 2016). Organisation A, a prominent African operator with a workforce of 6443 permanent and contracted staff in SA, is driven by its purpose and plays a key role in providing connectivity, digital and fintech services (Sustainability Report, 2022). The identified population for this study consisted of the technology group, comprising 1,282 actively involved ICT professionals and senior-level managers within Organisation A.

### 4.8.2 Sample size

Researchers are typically unable to study the entire population of interest or make every possible observation, requiring the selection of a sample from the available data for collection and study (Babbie, 2016). In a single-stage sampling procedure, the researcher directly samples individuals (or other elements) from the population using the names or data accessible to them (Creswell & Creswell, 2018). In the majority of business and management research, researchers typically seek to estimate the characteristics of the population with 95% certainty, providing a level of precision within a range of plus or minus 3% to 5% of the true values (Saunders et al., 2019). Krejcie and Morgan (1970) proposed an alternative formula for calculating sample size for categorical data, as shown below. Using the formula for calculating sample size with a known population and the finite population correction factor, the calculation is as follows:

n = (N * Z^2 * p * q) / [(N - 1) * e^2 + Z^2 * p * q]
n = (1282 * (1.96)^2 * 0.5 * 0.5) / [(1282 - 1) * (0.05)^2 + (1.96)^2 * 0.5 * 0.5]
n = (1282 * 3.8416 * 0.25) / [1281 * 0.0025 + 3.8416 * 0.25]
n = 1236.605 / [3.203025 + 0.9604]
n = 1236.605 / 4.163425

**n ≈ 297**

In this study, the objective was to examine the collective perceptions of ICT professionals and senior-level managers involved in ICT processes at Organisation A in order to investigate the challenges of transitioning to GICT. The determined sample size for this study was 297 actively involved ICT professionals and senior level managers within Organisation A.

### 4.8.3 Sampling techniques

Probability and non-probability are the two categories into which sampling procedures can be classified.

#### *4.8.3.1 Probability sampling*

Probability sampling guarantees that each case in the population has a known and typically equal chance of selection, enabling researchers to estimate population characteristics from the sample, thereby facilitating the answering of research questions and the achievement of objectives (Saunders et al., 2019). Probability sampling decreases researcher biases in selection and allows for the estimation of sampling error, providing a measure of how closely the sample represents the overall population (Babbie, 2016). Numerous techniques, including simple random sampling, systematic random sampling, stratified random sampling, multi-stage sampling and cluster random sampling fall under the umbrella of probability sampling methods (Saunders et al., 2019).

#### *4.8.3.2 Non-probability sampling*

In non-probability sampling, the possibility of each case being chosen from the entire population is unknown, making it infeasible to make statistical inferences about the population's attributes in relation to research questions or objectives (Saunders et al., 2019). Non-probability sampling methods, like using accessible subjects, purposive sampling, snowball sampling, quota sampling and engaging informants in social group studies, have their benefits; but none assure a sample that truly represents the studied population (Babbie, 2016).

### 4.8.4 Rationale for selecting probability sampling

In this research, probability sampling was utilised via the simple random sampling technique. To investigate the challenges faced by Organisation A during their shift to GICT, obtaining an unbiased and comprehensive sample is paramount. Simple random sampling is a probability sampling method where every individual in the population possesses an identical likelihood of being chosen for the sample (Saunders et al., 2019). Simple random sampling offers an unambiguous approach that guarantees each technology employee had an equal probability of being chosen, promoting reliable and comprehensive outcomes.

## 4.9 DATA COLLECTION

In both empirical and theoretical research, data are key for understanding phenomena and decision-making; in empirical studies, primary and/or secondary data is collected, with secondary data requiring careful assessment for relevance, accuracy and other factors and, at times, integration from multiple sources (Mukherjee, 2020). The research design determines the type, volume and quality of data with empirical studies often producing numerical data by measuring or counting specific characteristics of the study units (Mukherjee, 2020). When testing a hypothesis, a researcher may apply or adapt existing tools like questionnaires, interviews, schedules, observation techniques and rating scales, or create new ones to gather pertinent data (Pandey & Pandey, 2015).

### 4.9.1 Classification of data

In research, data is categorically separated into primary and secondary forms based on where it came from and how it was collected. Methods such as laboratory measurements, field observations and questionnaires can acquire primary data, while technical documents, official government publications, books, journals and various databases can source secondary data (Pandey & Pandey, 2015).

### 4.9.2 Research instrument

Within the quantitative techniques, two primary research instruments will be discussed: surveys and experiments. Survey research uses standardised tools like questionnaires or interviews to systematically capture people's preferences and behaviours, providing vital data

for practical applications and effective decision-making (Nayak & Singh, 2015). Survey research offers a numerical representation of the trends, attitudes or views of a population by examining a subset of that group (Saunders et al., 2019). Experimental research differs in its components and principles, but an effective design yields unbiased parameter estimates efficiently, using minimal resources and runs (Mukherjee, 2020). Experimental research assesses the effect of a particular treatment by comparing outcomes between a treated group and a control group (Saunders et al., 2019). In this research, the primary data collection instrument consisted of a questionnaire with structured questions and an open-ended question, administered through a survey.

### 4.9.3 Rationale for selecting a questionnaire

The questionnaire, as a widely employed data collection technique within the survey strategy, efficiently collects responses from a large sample by asking each respondent to answer the same set of questions, enabling subsequent quantitative analysis (Saunders et al., 2019). In a quantitative study, the use of both structured and semi-structured questions provides a balanced method for capturing quantifiable, standardised data while still allowing room for depth, context and exploratory insights. This questionnaire served as an instrument to gather information on various aspects, including the current state of ICT, strategies for implementing GICT and the perceived challenges and opportunities associated with this transition.

### 4.9.4 Construction of the questionnaire

The Likert scale is a tool in social research that uses standardised response options, such as "strongly agree" to "strongly disagree", to gauge the intensity of participants' feelings towards various statements (Babbie, 2016). The unit of analysis in this study was the individual employee working within the technology division of Organisation A. Data were collected from individual participants through a structured questionnaire to assess their perceptions, awareness, readiness, and views relating to Green ICT adoption. The responses of individual employees formed the basis for the statistical analysis and interpretation of the study findings. The quantitative data collection method utilised a five-point Likert scale questionnaire. A brief introductory section was added to the questionnaire to better explain the objectives of the research and increase participant understanding. Additionally, participants were advised about

the estimated time required to complete the questionnaire, ensuring transparency and managing their expectations.

The researcher developed the questionnaire to gather information from participants about the challenges faced when transitioning to GICT in Organisation A. The questionnaire is segmented into five parts, the first being the demographics and the balance of the five corresponding to the research objectives detailed in Table 4.2 below, aligning with the GITAM model constructs to address each of the research objectives. The content validity of the research instrument for this study was strengthened through the assistance of the statistician, who validated the constructs and variables.

**Table 4.2: Construction of the questionnaire**

| Section | Description |
|---|---|
| A | **Demographics and Background Information -** This section is designed to gather fundamental data regarding the participants' demographic attributes and backgrounds, facilitating a deeper understanding and interpretation of the survey results. |
| B | **Primary objective:** To identify the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT.<br>**GICT - Construct 1: Green IT Context:**<br>This section aims to identify key challenges faced by a South African telecommunications organisation in transitioning to Green ICT. It explores technological, organisational and environmental factors influencing the adoption; focusing on financial, operational, regulatory and cultural aspects that impact the process. The goal is to provide insights to address these challenges effectively. |
| C | **Secondary objective 1:** To evaluate the current state of Green ICT adoption within Organisation A.<br>**GICT - Construct 1: Green IT Context and Construct 3: Green IT Drivers:**<br>This section aims to evaluate the current state of Green ICT adoption within Organisation A. It focuses on assessing the extent and effectiveness of eco-friendly technology practices and initiatives within the organisation's existing ICT infrastructure. The findings will help to identify challenges in the adoption process, providing insights into areas where improvements can be made to support the organisation's transition to Green ICT. |
| D | **Secondary objective 2:** To investigate the challenges and barriers that impact Organisation A's transition to Green ICT.<br>**GICT - Construct 2: Green IT Readiness:**<br>This section explores the variety of challenges and barriers hindering Organisation A's transition to Green ICT. The focus is on understanding the internal challenges, such as cultural, organisational and readiness-related issues, as well as the external barriers, including technical limitations, financial constraints and regulatory hurdles. By examining both challenges and barriers, this study aims to provide deeper insights into factors that could complicate or delay Organisation A's Green ICT adoption and offers recommendations for overcoming these obstacles to ensure a smoother and more successful transition. |
| E | **Secondary objective 3:** To determine the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A.<br>**GICT - Construct 3: Green IT Drivers:** |

| Section | Description |
|---|---|
| | This section aims to assess the extent of employee awareness, involvement and perceptions regarding the Green ICT initiatives within Organisation A. By evaluating employee engagement and sentiment, this section seeks to understand how these factors influence the successful implementation of Green ICT practices. |
| F | **Secondary objective 4:** To provide recommendations on strategies for Organisation A to overcome challenges and barriers in their Green ICT implementation process.<br>**GICT - Construct 4: Intention to adopt Green IT:**<br>This section seeks to gather insights on potential strategies and actions that can be adopted by Organisation A to address and mitigate the identified challenges and barriers in their transition to GICT. |

**Source:** Author's creation (2024)

### 4.9.5 Administration of the questionnaire

A questionnaire can be self-administered, facilitated by the researcher or employ a blend of these techniques. There are three primary approaches to disseminating survey questionnaires to a set of participants: self-completed questionnaires, where individuals fill out the forms on their own; face-to-face interviews managed by interviewers and telephone-conducted surveys (Babbie, 2016). Self-completed questionnaires are usually more cost-effective and faster than face-to-face interview surveys (Babbie, 2016). In this study, the questionnaires were emailed for self-administration to the identified sample group within Organisation A, specifically the technology employee group, consisting of actively involved ICT professionals and senior-level managers.

## 4.10 DATA ANALYSIS

Data analysis takes a significant amount of a researcher's effort and requires cognitive skill to logically assess and interpret data, figures and outcomes. It frequently calls for the use of algorithms and software (Mukherjee, 2020). In this study, quantitative methods and techniques, including the t-test, correlation analysis and regression, was used to analyse the data. Descriptive statistics are used for condensing data into comprehensible formats, while inferential statistics enable conclusions to be drawn about a broader population based on the analysis of a sample taken from it (Babbie, 2016). Descriptive statistics were primarily used to provide an overview of the data, while inferential statistics were subsequently employed to examine the relationships between variables. The analysis was performed using Stata version 19 to derive meaningful insights and identify trends in the data. This quantitative analysis

approach provided a solid foundation for drawing conclusions and making evidence-based interpretations of the research findings. Effect sizes are key in research as they provide a measure of practical impact, enable cross-study comparisons and guide sample size determination for future research (Lakens, 2013). The magnitude of the impact that various factors had on the successful implementation of GICT in the SA telecommunications organisation was determined by evaluating the effect sizes in the research findings.

### 4.10.1 Correlation analysis

Correlation analysis examines the joint variation of two or more variables to determine the degree of correlation between them, which is crucial in social and business research for understanding and controlling relationships between variables rather than determining causes (Kothari & Garg, 2019). Correlation analysis is widely used in social science research to measure the association between variables, with linear correlation analysis employing the linear correlation coefficient (r or R) to indicate the closeness between related variables (Senthilnathan, 2019). Correlation analysis evaluates the linear relationship between variables using Pearson's correlation coefficient (r), ranging from -1 to 1. This study on GICT adoption helps examine relationships between employee attitudes, organisational readiness, technical barriers, market demand and financial barriers, identifying key factors influencing GICT adoption and guiding effective strategies.

### 4.10.2 Testing hypotheses

The t-test, correlation analysis and regression analysis will be employed to test the hypotheses. A null hypothesis is rejected when the probability of the test statistic is below a predetermined level of significance, denoted as alpha (α); otherwise, we do not reject it. Typically, alpha is set at levels of 0.01, 0.05 or 0.1.

***Testing hypothesis H1:*** The current state of Green ICT adoption in Organisation A is suboptimal.

The t-test will be employed to test Hypothesis 1, which posits that, on the Likert Scale, responses will be less than 4 or 5. In section B of the questionnaire, the statements concerning the effectiveness and adoption of Green ICT practices will be measured using a 5-point Likert scale, where 1 represents "strongly disagree" and 5 indicates "strongly agree". Mean scores for

these statements will be calculated and independent t-test results will be obtained to evaluate the null hypothesis that the mean score is equal to 3. Some mean scores may fall below 3, while others may be equal to or above 3, indicating that participants either generally disagreed (1 or 2), were neutral (3) or agreed (4 or 5) with the statements. Additionally, an overall mean score for the adoption of Green ICT practices will also be computed. If a statement receives a mean score of less than 3 (i.e. 1 or 2), this will suggest acceptance of the hypothesis that the current state of Green ICT adoption in Organisation A is suboptimal. Conversely, if the mean score is neutral (equal to 3), the hypothesis cannot be conclusively judged. If the mean score is greater than 3 (i.e. 4 or 5), this will indicate that the hypothesis is optimal. The one-sample t-test will be applied as shown below.

$$T = \frac{\overline{X} - \mu}{S/\sqrt{n}}$$

Where $\overline{X}$ is the mean score, with μ representing the assumed mean value (in this case, set at 3). S denotes the standard deviation of the scores, Xi refers to individual scores (where i = 1, 2, …, 30), and n indicates the sample size. The significance levels employed for this study will be 0.01, 0.05 or 0.1.

***Testing Hypothesis H2:*** There are significant challenges and barriers effecting Organisation A's transition to Green ICT. A t-test will be conducted to evaluate this hypothesis, which will be measured on a 5-point Likert scale, which will be assessed in Section D of the questionnaire. Additionally, multiple regression analysis may be employed to assess the influence of challenges and barriers on Organisation A's transition to Green ICT. In this context, "challenges and barriers" will serve as the independent variables, while "transition to Green ICT" or "current state of Green ICT adoption" will be treated as the dependent variable. The regression equation will be used as shown below.

$$Y = \alpha + \beta x + e$$

Where y is the current state of adoption of Green ICT, $x$ is a non-random variable (in this case, challenges and barriers) and $e$ is a random error distributed with mean zero and variance $\sigma^2$.

***Testing Hypothesis H3:*** A higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A. Correlation analysis will be conducted to evaluate this hypothesis, which will

be measured on a 5-point Likert scale, as outlined in Sections E and C of the questionnaire. The measure of association between $x$ and $y$ in the population is the correlation coefficient, calculated as:

$$r_{xy} = \frac{\text{cov}(x, y)}{\sqrt{\text{var}(x)\text{var}(y)}} = \frac{s_{xy}}{s_x . s_y}$$ ; range of $r_{xy}$ is $-1$ to $+1$

Correlation analysis will be conducted to measure the relationship between "employee perception" and the "implementation of Green ICT initiatives in Organisation A". The Pearson correlation coefficient will be used to quantify the strength of the linear relationship between these two variables. However, while the Pearson coefficient provides a measure of the linear association, it may not fully capture the complexity of their relationship.

## 4.11 PILOT STUDY

Pilot testing or field-testing the survey is key to evaluating content validity, internal consistency and participant fatigue concerns; enabling improvements to the questionnaire's quality and incorporating feedback from a designated number of individuals for final revisions to ensure instrument reliability and validity (Creswell & Creswell, 2018). A pilot study helps to estimate costs, refine methods, uncover questionnaire issues, introduce new insights and understand population variations, ensuring the main survey is optimised and any questionnaire ambiguities are addressed (Igwenagu, 2016). The pilot study was carried out with a group of 15 employees from the technology division of Organisation A. The questionnaire underwent testing with these participants to assess the appropriateness and suitability of the research instrument.

## 4.12 VALIDITY AND RELIABILITY

Reliability and validity are important benchmarks in quantitative research, reflecting the essential role of objectivity and the need for researchers to rigorously check their methods and results for potential biases (Creswell & Creswell, 2018). While reliability and validity are interlinked, they indicate different aspects of a measuring tool, suggesting that a tool can be reliable without being valid, but if it's valid, it's probably reliable too (Sürücü & Maslakci, 2020). In quantitative research, the validation of instrument scores through content validity, predictive or concurrent validity and construct validity assists in assessing the instrument's suitability for research while distinguishing it from identifying validity threats in experimental

research (Creswell & Creswell, 2018). Validity is determined when the data derived from the measuring instrument, following analysis, are interpreted in a meaningful and appropriate way (Sürücü & Maslakci, 2020).

### 4.12.1 Validity of data

Validity in research ensures properly designed data collection tools, discerns relationships within findings and determines if results can be generalised across various settings and researchers (Mukherjee, 2020). To ensure the validity of this research study, multiple measures were implemented. The variables and how they represented the research topic were examined through the use of descriptive statistics to provide a detailed overview of the data. On the basis of the gathered sample data, inferential statistics was used to investigate correlations and make reliable generalisations about the population. The latest Stata version was used for the analysis, making it possible to draw out important insights and spot important trends in the data. A measure of the practical impact was also provided through effect sizes, allowing accurate comparisons between studies and assisting in the selection of appropriate sample sizes for future research. Finally, the use of online survey tools for data collection ensured standardised administration and trustworthy data collection, thereby contributing to the study's validity. This research study maintained a high level of validity through these rigorous procedures, ensuring that the findings accurately reflected the research objectives and contributed to the body of knowledge in the field.

### 4.12.2 Reliability of data

Reliability, indicating an instrument's repeatability, is crucial; especially for internal consistency, which measures whether different items on the same instrument, intended to assess the same underlying concept, produce similar results. This highlights the need to examine if the instrument demonstrated satisfactory reliability in past use (Creswell & Creswell, 2018). Ensuring the reliability of a test does not guarantee its validity and, as such, both must be evaluated for any research instrument; failing to meet these criteria could lead to incorrect interpretation of the research findings (Sürücü & Maslakci, 2020). To enhance the reliability of the data collected in this research study, several measures were implemented. These measures included meticulous questionnaire design, randomisation and control during questionnaire administration; ensuring an appropriate sample size; monitoring data quality;

employing suitable statistical analysis techniques (including descriptive and inferential statistics); considering effect sizes for practical significance and utilising the reliable online survey platform, Lime Survey. The data will be preserved for a period of five years and may be used for publication in an academic journal article. These strategies were applied within the context of a telecommunications organisation, aiming to bolster the reliability and credibility of the research findings.

## 4.13 ETHICAL CONSIDERATIONS

Research ethics is about ensuring that every aspect of research, from topic selection, design, data collection, processing, storage, analysis and report writing, is conducted in a morally responsible manner that is both methodologically rigorous and ethically defensible to all involved parties (Saunders et al., 2019). The researcher followed the Research Ethics Policy of UNISA throughout the study (UNISA, 2023). To ensure adherence to ethical standards, the researcher sought and obtained permission from the ethics committee of the University of South Africa (Unisa) and complied with the institution's policy on research ethics. The study prioritised ethical considerations by taking several measures. Research ethics clearance was obtained from Unisa's ethics committee, supported by a letter from the university's regional centre.

Researchers must obtain approval from gatekeepers before conducting a study, typically through a letter detailing the study's duration, potential impact and expected outcomes (Creswell & Creswell, 2018). Permission was obtained from the Public Affairs Department and the Executive Head of Department of the researcher in Organisation A, who acted as the gatekeeper for the study. Participation will be voluntary, allowing participants to choose not to participate. These ethical considerations demonstrate a commitment to protecting participants and upholding research integrity within the telecommunications organisation under study and the University of SA community.

The concept of informed consent formalises the ethical norms of voluntary participation and no harm to participants, requiring that subjects fully understand the potential risks before voluntarily participating in research (Babbie, 2016). Participants and the organisation's management were provided with a participant consent form, which explained the purpose of the study and obtained their informed consent. To safeguard participants, the study ensured

that no physical or emotional harm was inflicted. The participant information sheet explained the study's purpose, the reason for Organisation A's technology department's participation, and details regarding participation, withdrawal, confidentiality, data security and the communication of findings. This is included in Annexure A. Additionally, a consent form was provided to Organisation A's technology employees, ensuring that they understood the purpose of the study, its voluntary nature, and their right to opt out. The consent form and questionnaire are included in Annexure B.

Confidentiality and anonymity are crucial for gaining access to organisations and individuals. Once these promises are made, it is essential to maintain them by ensuring the collected data remains confidential (Saunders et al., 2019). Confidentiality was maintained by omitting names from the questionnaires and advising participants not to disclose any identifying information. All study documents were securely stored either in a locked environment or in password-protected digital files. A confidentiality agreement, shown in Annexure C, was signed by the statistician.

## 4.14 LIMITATIONS OF THE STUDY

It is the responsibility of researchers to openly acknowledge and address any technical limitations and failures encountered during the study (Babbie, 2016). Limitations in a study encompass potential weaknesses beyond the researcher's control, arising from factors such as research design, statistical models, funding constraints and other relevant variables, imposing restrictions that must be acknowledged to comprehend the study's scope and implications fully (Theofanidis & Fountouki, 2018). A potential obstacle in the study was non-response from the selected population and participants. To mitigate this challenge, the researcher ensured that the questionnaire instructions were clear and easy to understand. In addition, the potential benefits of the research, including promoting sustainability, reducing environmental impact and improving Organisation A's efficiency, were communicated to encourage participation and improve response rates. Furthermore, the focus on a single telecommunications organisation (Organisation A) limited the generalisability of the findings, as unique organisational characteristics, regulatory environments and market dynamics may influence Green ICT (GICT) adoption differently. Consequently, the findings are specific to Organisation A and may not be fully applicable to other organisations or industries.

### 4.14.1 Delimitations

Delimitations are self-imposed boundaries set by researchers to define the scope of their study, ensuring that the aims and objectives are achievable and are concerned with theoretical background, objectives, research questions, variables and the study sample (Theofanidis & Fountouki, 2018). The delimitations of this study refer to the self-imposed boundaries that define the scope and focus of the research, ensuring that the study remains manageable and the objectives are achievable. These include decisions on the theoretical framework, research questions, variables under investigation and the specific sample from Organisation A. By setting these limits, the study aims to maintain a clear and focused approach while acknowledging that findings may not be generalisable beyond the chosen context.

### 4.14.2 Assumptions

An assumption is a fundamental condition taken for granted, forming the essential basis of a research project, and researchers explicitly state these assumptions to underpin their study (Leedy, Ormrod & Johnson, 2019). This study assumes that employees from Organisation A will provide honest and accurate responses to the survey questions. It also assumes that participants have a basic understanding of GICT concepts and practices. Additionally, the findings from Organisation A are expected to be relevant and potentially applicable to similar telecommunications organisations. The study presumes that the organisational and technological environment will remain stable during the research period, with no significant changes affecting the findings. Lastly, it is assumed that the researcher will have full access to the necessary data and participants within Organisation A to conduct the study.

### 4.14.3 Elimination of Bias

Bias in research, whether intentional or unintentional, leads to false conclusions and is unethical, necessitating awareness and actions by scientists to minimise deviations from the truth (Šimundić, 2013). Since this study involves collecting survey data through questionnaires, the focus would be on ensuring anonymity and confidentiality to reduce bias; ensuring that participants' identities are not linked to their responses to encourage honest answers and inform them that their responses will be kept confidential. Using a standardised set of questions and conducting pilot testing to identify and correct potential biases. Provide clear and concise

instructions for completing the questionnaire. Implementing these practices will help ensure reliable and valid data, reducing the impact of bias.

## 4.15 CONCLUSION

Chapter 4 outlined the research design and methodology for studying the challenges and barriers to transitioning to GICT within a South African telecommunications organisation. It covered the research philosophy, approach and justification for choosing a quantitative method. The chapter elaborated on the descriptive research design and survey strategy, as well as the population and sampling process. Data collection methods, including questionnaire construction and administration, were explained. Pilot studies, validity, reliability, ethical considerations, limitations, delimitations, assumptions and strategies to eliminate bias were also addressed. This chapter sets a solid foundation for data analysis and interpretation.

Next Chapter 5 will present the study's data analysis and interpretation of the results.

# CHAPTER 5
# DATA ANALYSIS AND INTERPRETATION OF RESULTS

## 5.1 INTRODUCTION

The preceding chapter outlined the research methodology used in this study, including the sampling strategy, data collection procedures and statistical techniques. This chapter presents a detailed analysis of the data and a discussion of the results obtained through the online questionnaire. The analysis is structured according to the Green IT Adoption Model (GITAM), which was introduced in Chapter 3 (§3.9) to frame the study and define the relevant constructs. The findings are interpreted in relation to the statistical procedures undertaken, offering insights drawn from respondents' responses. To effectively address the research questions outlined in this study (§2.4), both a primary and a set of secondary research objectives were established:

- **Primary Objective:**
    - To identify the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT.
- **Secondary Objectives:**
    - To evaluate the current state of Green ICT adoption within Organisation A.
    - To investigate the challenges and barriers that impact Organisation A's transition to Green ICT.
    - To determine the level of employee awareness, involvement and perceptions regarding the green ICT initiatives in Organisation A.
    - To provide recommendations on strategies for Organisation A to overcome challenges and barriers in their Green ICT implementation process.

The research questions, research objectives and research problem are directly aligned to the four Green ICT constructs namely, Green IT Context, Green IT Readiness, Green IT Drivers and Intention to Adopt Green IT. These were derived from the GITAM model discussed in the literature review and further examined in this chapter.

Accordingly, this study adopted a positivist research philosophy and employed a quantitative approach to examine the challenges faced by a South African telecommunications organisation

in its transition to Green ICT (GICT). A mono-method, quantitative survey design was implemented, using a cross-sectional time horizon to capture perceptions at a specific point in time. Data were collected through a self-administered structured online questionnaire distributed to employees and key stakeholders within Organisation A. The analysis is presented in accordance with the structure outlined in Figure 5.1, including both closed-ended and open-ended responses, with section F specifically addressing respondents' suggestions and recommendations.

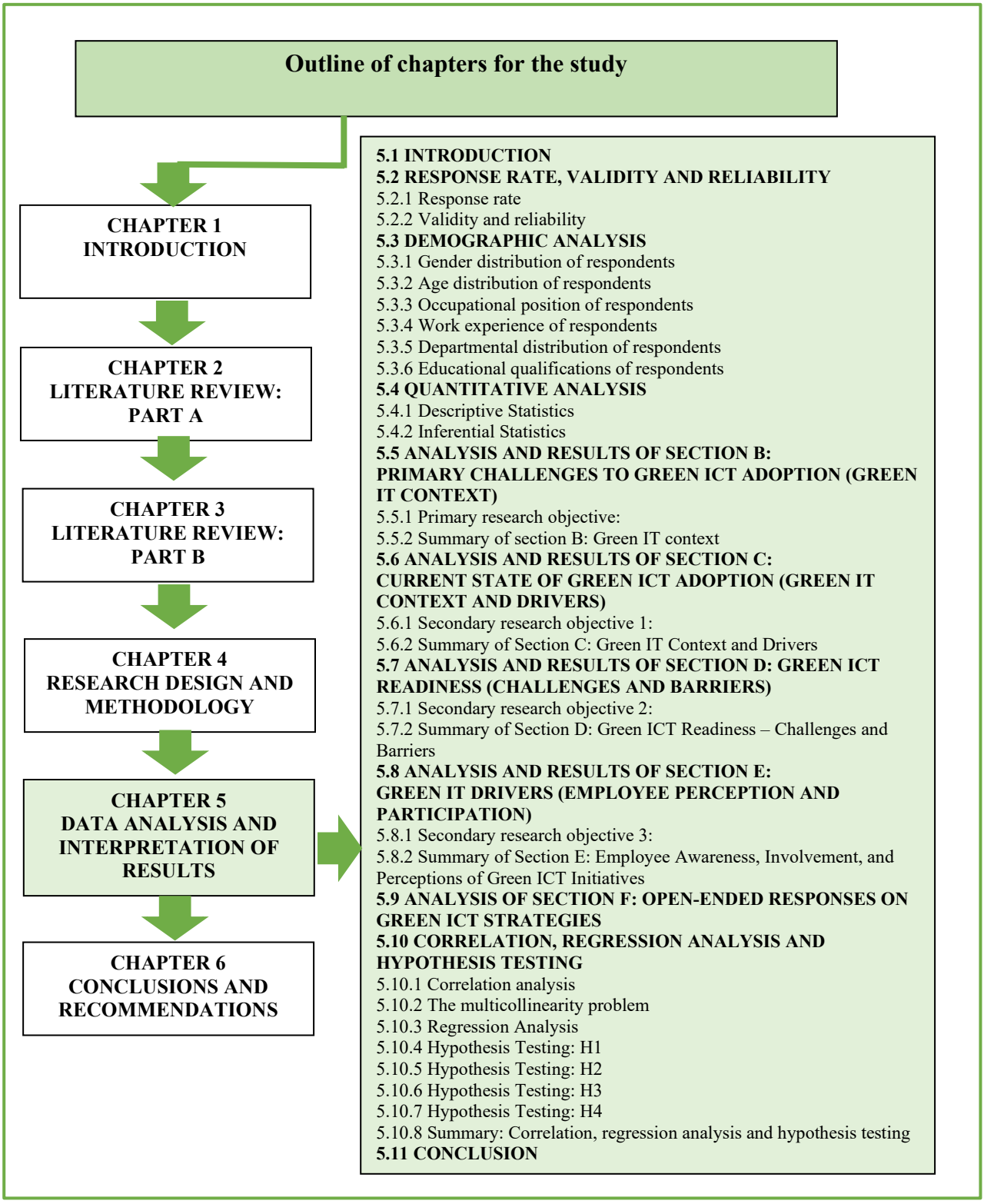


**Figure 5.1**: Outline of Chapter 5

**Source:** Author's compilation (2025)

Chapter 5 begins with an introductory overview (§5.1), followed by a discussion of the response rate, validity and reliability of the study in §5.2. A demographic analysis of the respondents is presented in §5.3. Section 5.4 provides an overview of the analytical approach for sections B to E, while sections 5.5 to 5.9 present the statistical analyses of each respective section. Section 5.10 discusses the correlation and regression analyses used to test the study's hypotheses and finally, section 5.11 concludes the chapter with a summary.

## 5.2 RESPONSE RATE, VALIDITY AND RELIABILITY

This section outlines the response rate of the study and evaluates the validity and reliability of the data collection instrument.

### 5.2.1 Response rate

The response rate, which reflects the proportion of respondents who completed the survey, is one of the key factors influencing the validity and reliability of a research study (Taherdoost & Madanchian, 2024). Research relies so much on the willingness of the potential respondents to positively respond to the questionnaire. In social science research, it is not uncommon to obtain a response rate of less than 100%.

A total sample size of 297 was determined using Krejcie and Morgan's (1970) formula for a known population. The study targeted ICT professionals and senior-level managers at Organisation A to gather perceptions regarding the challenges of transitioning to Green ICT (GICT). Further detail on the sample size calculation was provided in Chapter 4 (§4.8.2). Data collection for this study was conducted over a period of six weeks, from 29 January 2025 to 11 March 2025, using a self-administered online questionnaire distributed via Lime Survey. The survey consisted of 63 questions across eight pages and respondents were required to complete each page before proceeding to the next, ensuring that all questions—except for the final, optional recommendation question—were mandatory. This design helped to ensure high-quality, complete responses. To enhance participation, weekly email reminders were sent to all selected respondents and individual follow-up reminders were conducted via Microsoft Teams. These strategies contributed to a strong level of participation and the data collected were sufficient to address the research objectives. The responses obtained formed the basis for the statistical analysis presented in this chapter.

Of the 297 questionnaires distributed for this study, a total of 232 were returned, yielding a response rate of approximately 78%. However, 27 of these were partially completed or abandoned and thus excluded from analysis. This resulted in 205 fully completed questionnaires being used for the study, forming the dataset for statistical analysis and interpretation. The final dataset, consisting of 205 fully completed questionnaires, was subsequently assessed for validity and reliability to ensure the integrity and quality of the data used in the analysis.

### 5.2.2 Validity and reliability

In quantitative research, validity refers to the extent to which a measurement instrument appropriately aligns with the concept being studied and produces results that accurately reflect real-world conditions (Nha, 2021). For the purposes of this study, validity was supported through the alignment of the questionnaire items with both the Green ICT constructs derived from the GITAM model and the study's research objectives, ensuring that the instrument was conceptually relevant and appropriately tailored to the organisational context. Quantitative research places emphasis on the consistency of research findings and their ability to be replicated across different contexts (Nha, 2021). In this study, reliability was supported through the consistent structure of the questionnaire, which used clearly formulated, standardised questions to ensure uniform understanding and responses across all respondents.

Validity and reliability tests are used to demonstrate whether constructs measure what they are supposed to measure. In quantitative research, validity can be achieved if the researcher manages to draw meaningful and useful inferences from scores on a questionnaire (Rose & Johnson 2020). The questionnaire used in this study was piloted and refined based on feedback received to improve clarity and relevance of the research instrument. Overall, respondents indicated that the questions were clear, direct and free from ambiguity, thereby enhancing the reliability of the instrument. The final version of the questionnaire was administered online using Lime Survey and the collected data were analysed using the Stata statistical software package to ensure accurate and rigorous statistical interpretation.

## 5.3 DEMOGRAPHIC ANALYSIS

Understanding the sociodemographic characteristics of survey respondents is essential for contextualising their responses and identifying variations in beliefs, opinions and behaviours across sub-populations, which is critical for uncovering and addressing underlying disparities (Ziegenfuss, Easterday, Dinh, JaKa, Kottke & Canterbury, 2021). This section outlines the demographic characteristics of the individuals who participated in the study**.** Respondents included ICT professionals and senior-level managers from Organisation A who completed section A of the online questionnaire. This section of the survey collected key background information, including gender, age group, job position, years of experience, department and highest level of education. These respondents were selected based on their involvement in ICT-related functions, making them well-positioned to provide meaningful input on the organisation's transition to Green ICT. To ensure consistency and reliability in the findings, only fully completed questionnaires were considered, resulting in a total of 205 valid responses. Descriptive analysis was used to summarise the data, and percentages were presented to two decimal places for accuracy. The demographic information presented here not only adds context to the study but also supports the interpretation of the results in line with the stated research objectives.

### 5.3.1 Gender distribution of respondents

This section presents the gender distribution of the respondents who participated in the study. The objective is to provide a breakdown of respondents across the gender categories: male, female and not specified. Table 5.1 and Figure 5.2 display the frequency and percentage values for each category, based on the total number of valid responses (n = 205).

**Table 5.1: Gender distribution of respondents**

| Gender | Frequency | Cumulative Percentage |
|---|---|---|
| Male | 146 | 71.22% |
| Female | 58 | 28.29% |
| Not specified | 1 | 0.49% |
| **Total:** | **205** | **100.00%** |

**Source:** Author's Compilation (2025)

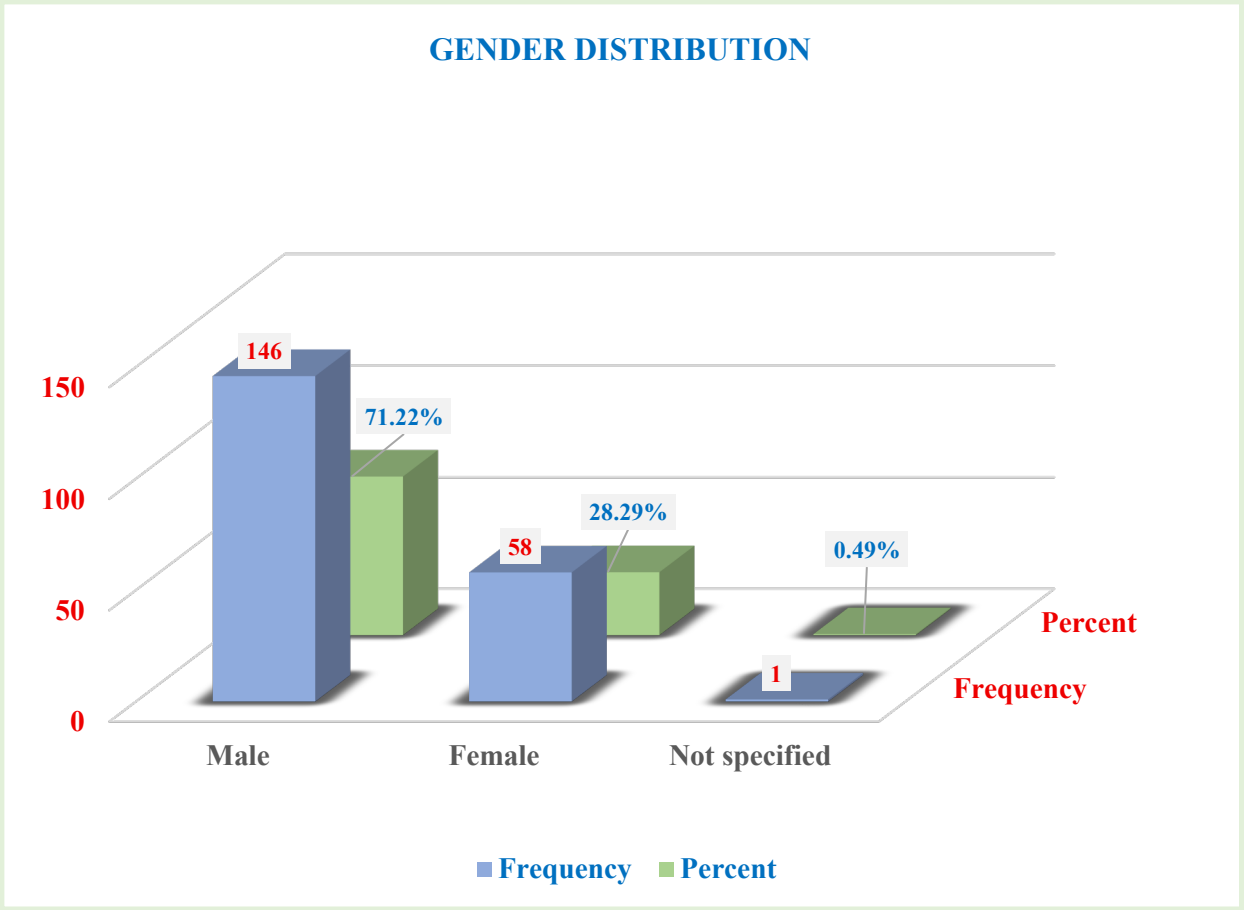


**Figure 5.2**: Gender distribution of respondents

**Source:** Author's Compilation (2025)

The results show that out of a total of 205 valid responses, the majority of respondents were male (n = 146; 71.22%), followed by female respondents (n = 58; 28.29%). Only one respondent (n = 1; 0.49%) selected "Not specified" as their gender. These results reflect the gender composition of ICT professionals and senior-level managers at Organisation A who completed the questionnaire. Figure 5.1 visually reinforces the predominance of male respondents in the sample. This section presents an analysis of the age demographics of the survey respondents.

### 5.3.2 Age distribution of respondents

This section presents the age distribution of respondents within Organisation A. Respondents were asked to indicate their age group to support the contextualisation of the data in terms of generational experience and insight. Table 5.2 and Figure 5.3 present the frequency and

percentage distribution of respondents across the specified age categories, based on a total of n = 205 valid responses.

**Table 5.2: Age distribution of respondents**

| Age (Years) | Frequency | Percentage | Cumulative Percentage |
|---|---|---|---|
| 18 - 25 | 5 | 2.44% | 2.44% |
| 26 – 35 | 21 | 10.24% | 12.68% |
| 36 – 45 | 78 | 38.05% | 50.73% |
| 46 – 55 | 91 | 44.39% | 95.12% |
| 56 – 65 | 10 | 4.88% | 100.00% |
| **Total:** | **205** | **100.00** | |

**Source:** Author's Compilation (2025)

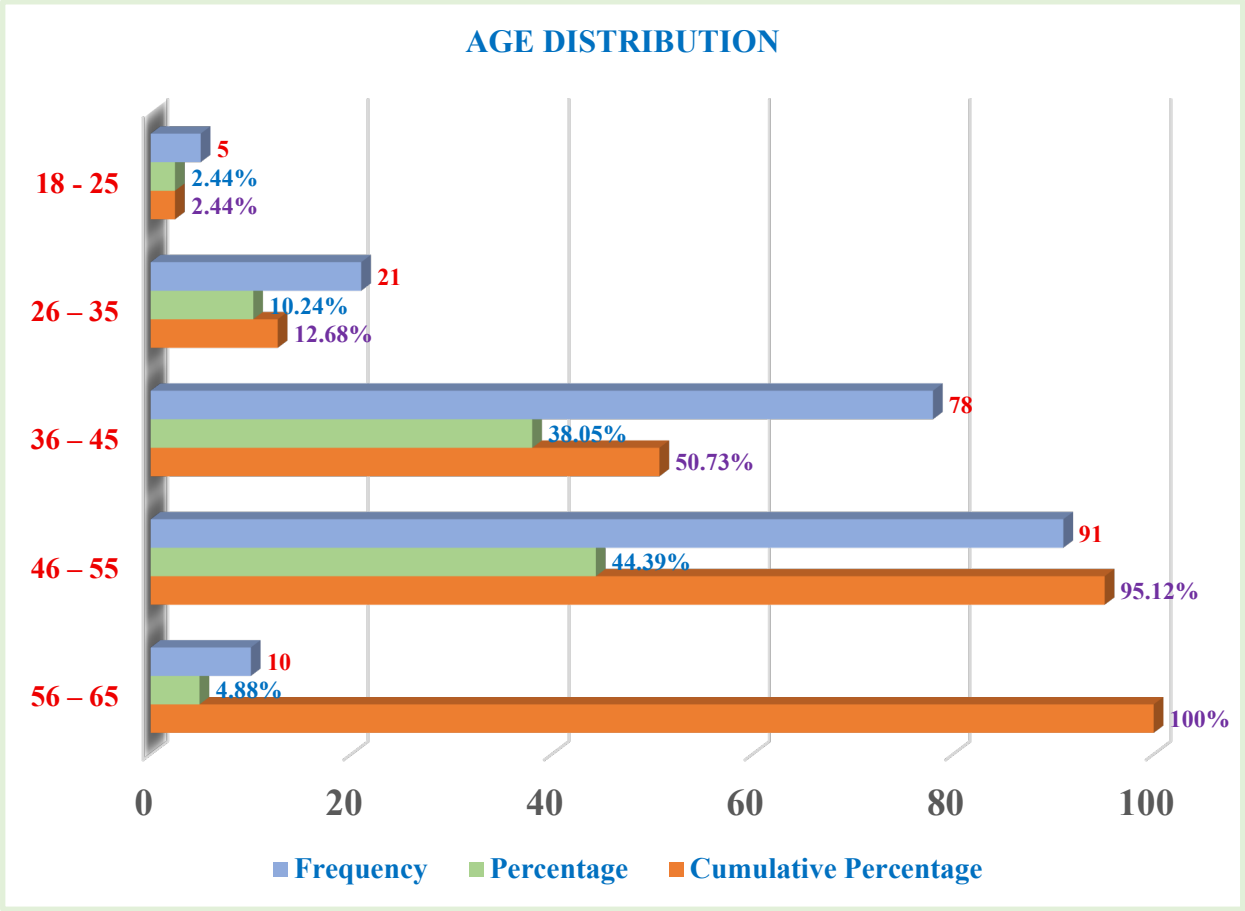


**Figure 5.3**: Age distribution of respondents

**Source:** Author's Compilation (2025)

The results show that the majority of respondents were between the ages of 36–45 (n = 78; 38.05%) and 46–55 (n = 91; 44.39%), together accounting for more than 82% of the total

responses. This concentration suggests that middle-aged professionals formed the core of the respondent base. These respondents are likely to have accumulated significant experience within the organisation, positioning them to offer informed perspectives on Green IT practices. The 26–35 age group (n = 21; 10.24%) formed a smaller but notable portion of the sample, representing younger professionals likely in mid-career stages. The youngest group, aged 18–25 (n = 5; 2.44%) and the oldest, aged 56–65 (n = 10; 4.88%), were the least represented. Figure 5.3 visually reinforces the distribution of age groups among respondents**.** The following section presents an analysis of the occupational positions held by respondents within Organisation A.

### 5.3.3 Occupational position of respondents

This section presents the professional positions of the respondents within Organisation A. Respondents were asked to specify their roles to ensure that the insights gathered reflect the perspectives of individuals directly engaged in ICT-related decision-making processes. Table 5.3 and Figure 5.4 present the frequency and percentage distribution of respondents by job title, based on a total of n = 205 valid responses, illustrating the spread of the sample across various technical and managerial levels within the organisation.

**Table 5.3: Occupational position of respondents**

| Position | Frequency | Percentage | Cumulative Percentage |
|---|---|---|---|
| Technical Assistance | 9 | 4.39% | 4.39% |
| Technical Officer | 5 | 2.44% | 6.83% |
| Senior Technical Officer | 4 | 1.95% | 8.78% |
| Specialist | 72 | 35.12% | 43.90% |
| Senior Specialist | 67 | 32.68% | 76.58% |
| Principal Specialist | 3 | 1.46% | 78.04% |
| Manager | 35 | 17.07% | 95.11% |
| Executive Head of Department | 6 | 2.93% | 98.04% |
| Managing Executive | 4 | 1.95% | 100.00% |
| **Total:** | **205** | **100.00%** | |

**Source:** Author's Compilation (2025)

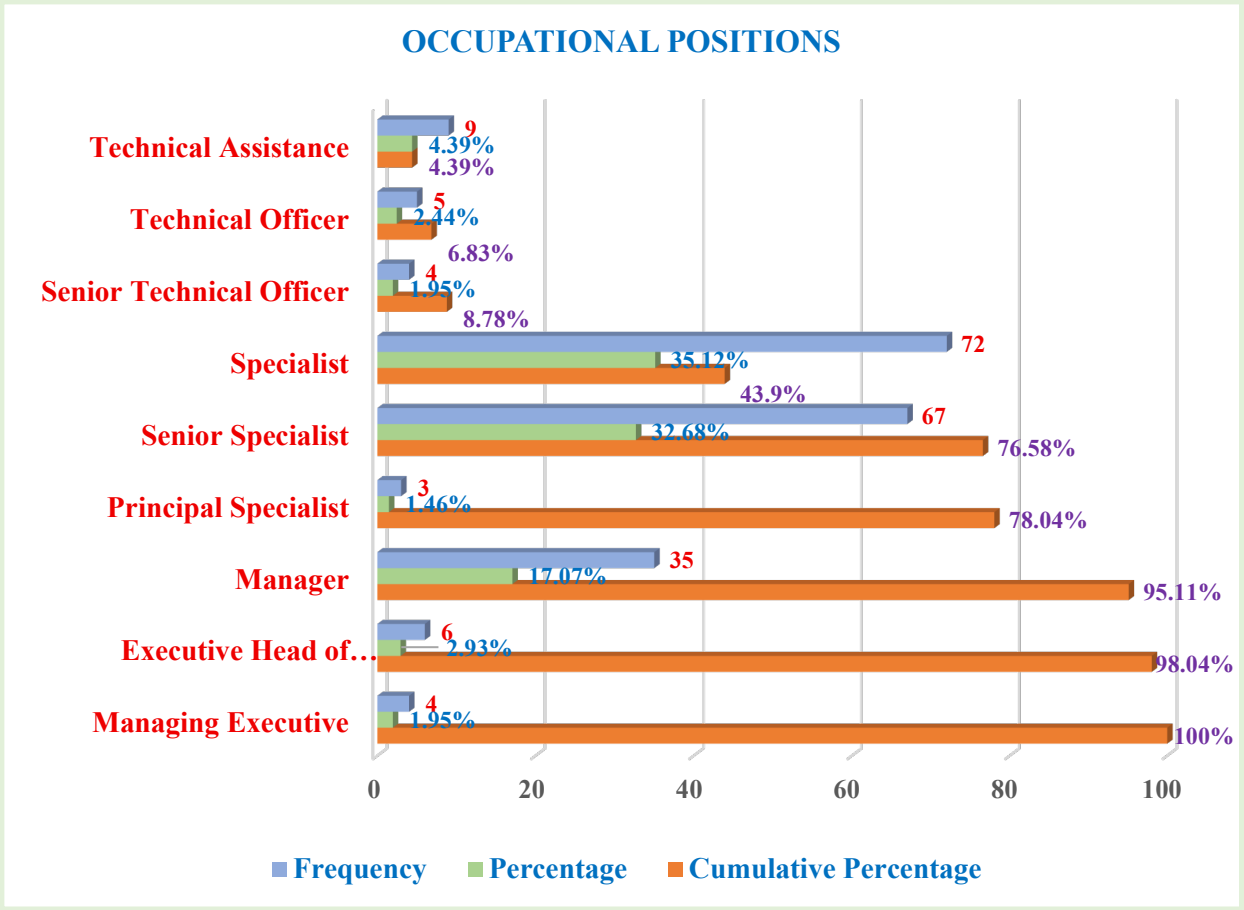


**Figure 5.4:** Occupational positions of respondents

**Source:** Author's Compilation (2025)

The results show that the majority of respondents were specialists (n = 72; 35.12%), followed by senior specialists (n = 67; 32.68%) and managers (n = 35; 17.07%). Other reported roles included technical assistance (n = 9; 4.39%), technical officer (n = 5; 2.44%), executive head of department (n = 6; 2.93%), managing executive (n = 4; 1.95%), senior technical officer (n = 4; 1.95%) and principal specialist (n = 3; 1.46%). Figure 5.4 provides a visual representation of the distribution across these occupational categories. The following section presents an analysis of respondents' years of work experience at Organisation A.

### 5.3.4 Work experience of respondents

This section presents the distribution of respondents' work experience within Organisation A. Understanding the length of service among respondents helps contextualise their perspectives on Green ICT, particularly in relation to institutional knowledge and practical exposure. Table

5.4 and Figure 5.5 display the frequency and percentage of respondents across each experience category, based on the total number of valid responses (n = 205).

**Table 5.4: Work experience distribution of respondents**

| Experience (years) | Frequency | Percentage | Cumulative Percentage |
|---|---|---|---|
| 1 to 2 | 14 | 6.83% | 6.83% |
| 3 to 5 | 13 | 6.34% | 13.17% |
| 6 to 10 | 36 | 17.56% | 30.73% |
| 11 to 15 | 68 | 33.17% | 63.90% |
| 16 to 20 | 39 | 19.02% | 82.92% |
| More than 20 | 35 | 17.07% | 100.00% |
| **Total:** | **205** | **100.00%** | |

**Source:** Author's Compilation (2025)

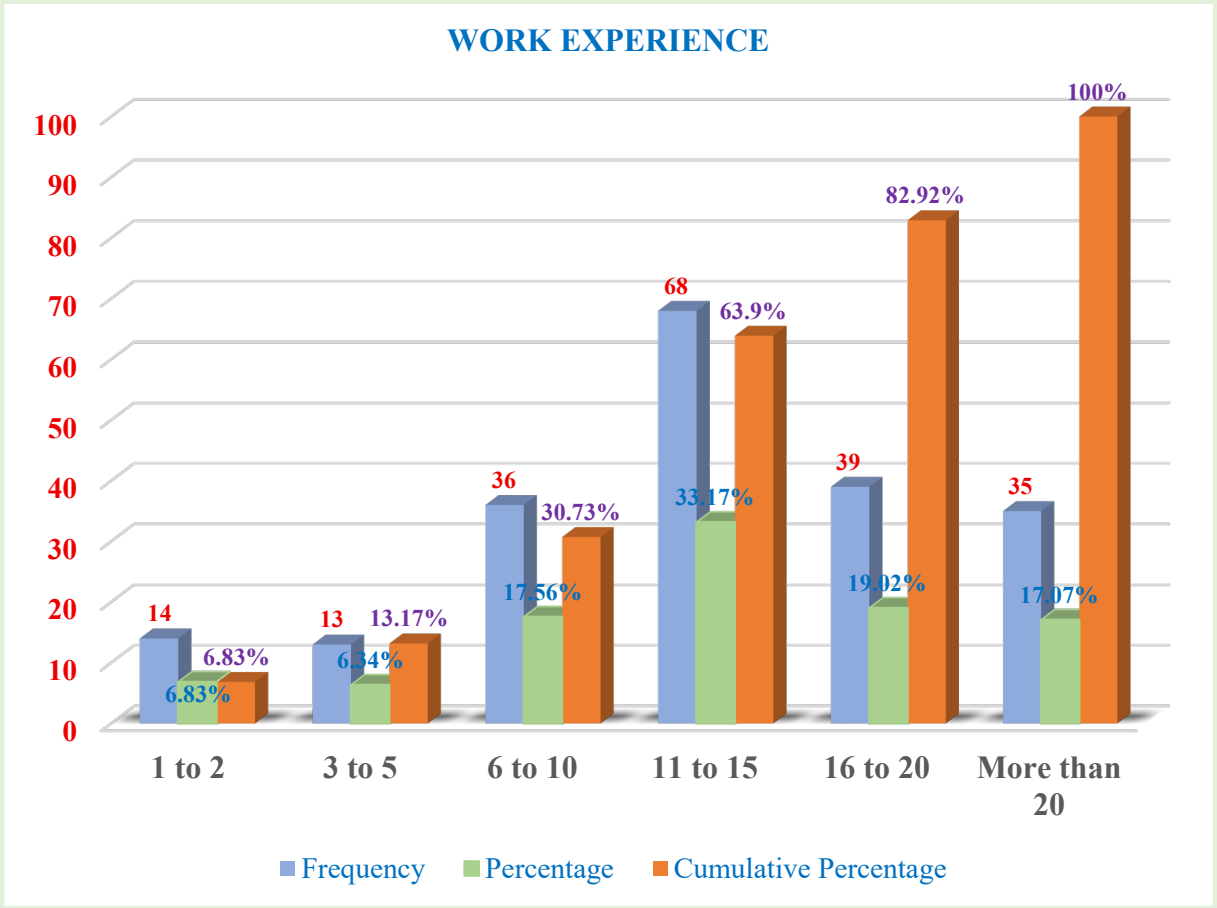


**Figure 5.5:** Respondents' years of work experience

**Source:** Author's Compilation (2025)

The results show that the largest proportion of respondents reported having between 11 to 15 years of experience (n = 68; 33.17%), followed by those with 16 to 20 years (n = 39; 19.02%) and more than 20 years (n = 35; 17.07%). These three categories combined represent nearly 70% of the total sample, suggesting that a majority of respondents possess considerable institutional knowledge and exposure to ICT practices within the organisation. Fewer respondents reported shorter tenures: 6 to 10 years (n = 36; 17.56%), 1 to 2 years (n = 14; 6.83%) and 3 to 5 years (n = 13; 6.34%). Figure 5.5 provides a visual summary of the distribution across all experience categories. The next section presents an analysis of the departmental affiliation of respondents.

### 5.3.5 Departmental distribution of respondents

This section presents the analysis of the departments in which the respondents work within Organisation A. Respondents were required to indicate the department in which they were employed to assist in contextualising their perspectives based on functional areas. Table 5.5 and Figure 5.6 below present the frequency and percentage distribution of respondents by department, based on a total of valid responses (n = 205).

**Table 5.5: Departmental distribution of respondents**

| Department | Frequency | Percentage | Cumulative Percentage |
|---|---|---|---|
| Core Network Engineering – CNE, Cybers. | 26 | 12.68% | 12.68% |
| Energy Operations | 5 | 2.44% | 15.12% |
| Enterprise Technology and FFTX Group | 21 | 10.24% | 25.36% |
| Network Programme Management | 14 | 6.83% | 32.19% |
| Radio Access Network Engineering | 15 | 7.32% | 39.51% |
| Regional Operations | 61 | 29.76% | 69.27% |
| Technology Strategy Arc and Assurance | 3 | 1.46% | 70.73% |
| Transmission Access and Transport Eng. | 48 | 23.41% | 94.14% |
| Other | 12 | 5.85% | 100.00% |
| **Total:** | **205** | **100.00%** | |

**Source:** Author's Compilation (2025)

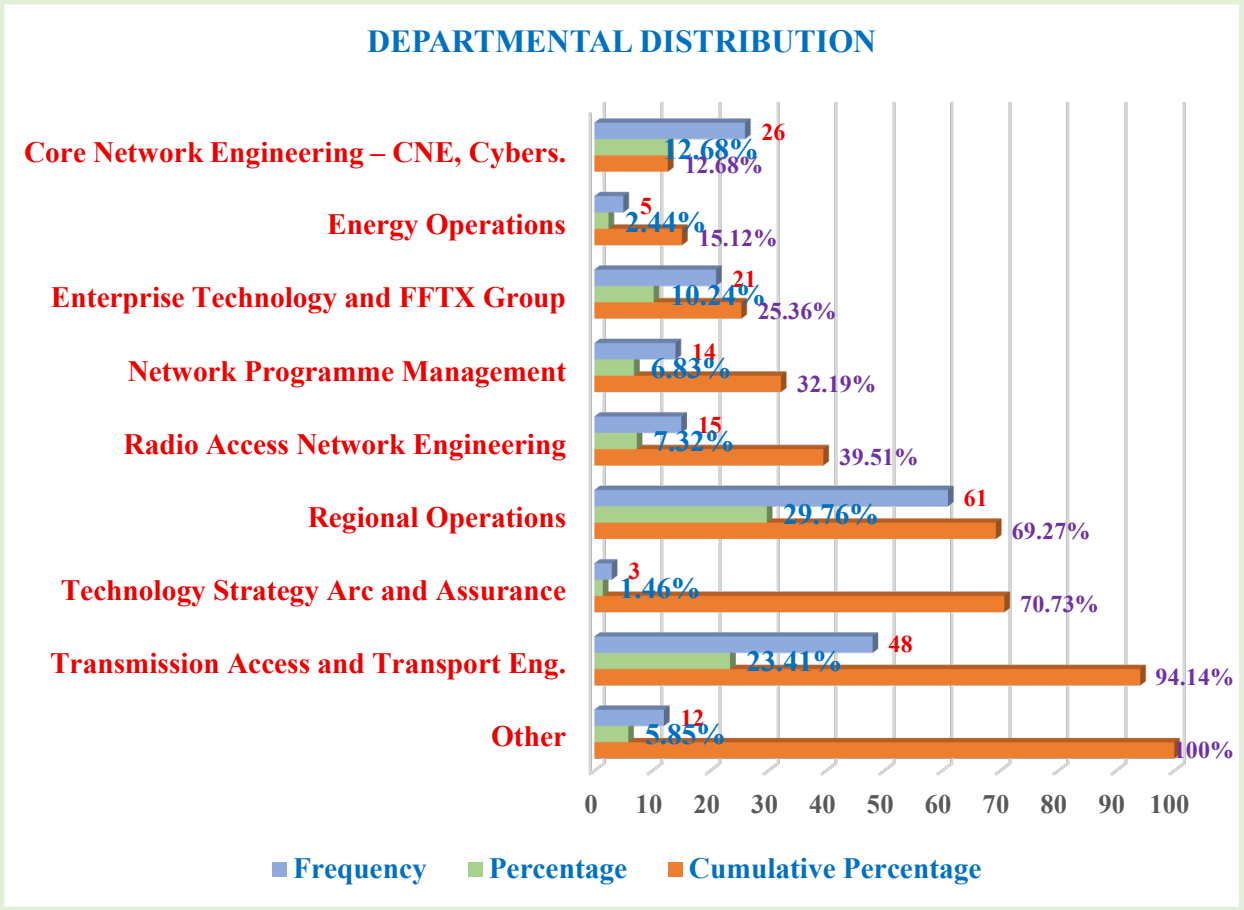


**Figure 5.6: Departmental distribution of respondents**

**Source:** Author's Compilation (2025)

The results indicate that the highest number of respondents were from the regional operations department (n = 61; 29.76%), followed by transmission access and transport engineering (n = 48; 23.41%) and core network engineering – CNE, cybers. (n = 26; 12.68%). Respondents also represented departments such as enterprise technology and FFTX Group (n = 21; 10.24%), network programme management (n = 14; 6.83%) and radio access network engineering (n = 15; 7.32%). Fewer responses came from energy operations (n = 5; 2.44%), technology strategy architecture and assurance (n = 3; 1.46%) and the 'Other' category (n = 12; 5.85%). Figure 5.6 visually illustrates the departmental distribution of the respondents.

### 5.3.6 Educational qualifications of respondents

This section aimed to identify the highest level of education attained by respondents within Organisation A. Respondents were asked to indicate their qualifications to help contextualise the findings based on educational background. Table 5.6 and Figure 5.7 present the frequency

and percentage distribution of respondents by education level, based on a total of valid responses (n = 205).

**Table 5.6: Educational qualifications analysis of respondents**

| Education | Frequency | Percentage | Cumulative Percentage |
|---|---|---|---|
| High school | 4 | 1.95 | 1.95 |
| Diploma or equivalent | 65 | 31.71 | 33.66 |
| Bachelor's degree or Honours degree | 98 | 47.80 | 81.46 |
| Master's degree or Doctoral degree | 37 | 18.05 | 99.51 |
| Other | 1 | 0.49 | 100.00 |
| **Total:** | **205** | **100.00** | |

**Source:** Author's Compilation (2025)

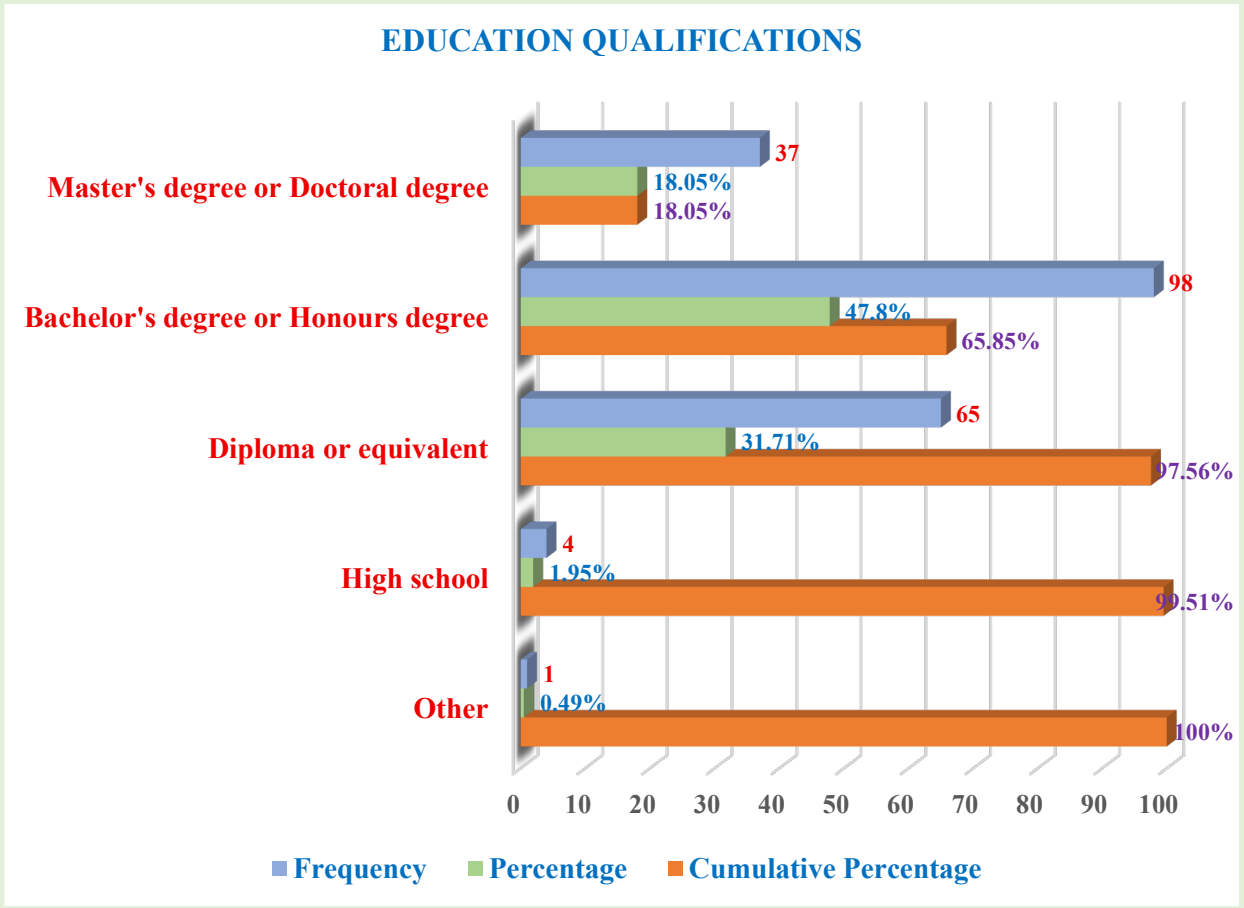


**Figure 5.7:** Educational qualifications of respondents

**Source:** Author's Compilation (2025)

The results show that the majority held a bachelor's degree or honours degree (n = 98; 47.80%), followed by those with a diploma or equivalent qualification (n = 65; 31.71%) and a master's degree or doctoral degree (n = 37; 18.05%). A small number of respondents reported a high school education (n = 4; 1.95%) or selected 'Other' (n = 1; 0.49%), with one respondent specifying an N4 qualification in electrical engineering. Figure 5.7 visually illustrates this educational distribution.

The following section outlines the quantitative analysis conducted in this study, detailing the descriptive and inferential statistical methods used to evaluate the survey responses.

## 5.4 QUANTITATIVE ANALYSIS

In this study, quantitative analysis was conducted using data collected from a structured questionnaire administered to employees within a South African telecommunications organisation. The questionnaire comprised closed-ended items measured on a five-point Likert scale, allowing for the evaluation of employee perceptions regarding Green ICT adoption. The responses were analysed using both descriptive statistics (mean and standard deviation) and inferential statistics, specifically one-sample t-tests, to determine statistical significance.

The research was underpinned by the Green Information Technology Adoption Model (GITAM), developed by Molla (2008), which explains and predicts the adoption of green IT practices in organisations. GITAM incorporates the Technology-Organisation-Environment (TOE) framework, introduced by Tornatzky and Fleischer (1990), to categorise influencing factors into three dimensions: technological, organisational and environmental. In this study, these dimensions were used to structure the analysis of questionnaire sections B to E.

Section B focused on Construct 1 (Green IT Context); section C addressed both Construct 1 and Construct 3 (Green IT Drivers); section D aligned with Construct 2 (Green IT Readiness) and section E focused on Construct 3. While GITAM provided the theoretical and conceptual foundation for the research, the TOE framework was used as a classification lens to group and interpret variables. This integrated approach ensured that the analysis was both theory-driven and contextually relevant, offering comprehensive insights into the challenges, readiness and motivational dynamics influencing Green ICT adoption in Organisation A.

### 5.4.1 Descriptive Statistics

Descriptive statistics were applied to summarise and describe the central tendencies and variability of responses for each variable. This involved calculating the frequency distributions, mean scores and standard deviations of all variables to gain a clear picture of how respondents rated the challenges to Green ICT adoption. These measures help condense large volumes of response data into meaningful and interpretable summaries, enabling the identification of which items elicited stronger agreement, disagreement or neutrality (Navarro & Foxcroft, 2025). In this study, the mean scores of the items that measured the constructs provided insight into the general direction of respondent opinions. Some of the mean scores were below 3, others were around 3 and some were above 3; indicating that the respondents generally disagreed, remained neutral or agreed with the statements, respectively. This descriptive overview helped identify overall trends before moving to inferential analysis.

#### *5.4.1.1 Mean Scores*

In this study, the items of the variables or constructs were measured on a 5-point Likert scale, where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. The following tables present the frequency distributions, mean scores of the items that measured the constructs and the independent t-test results; testing the null hypothesis that the mean score is equal to 3. Some of the mean scores were below 3 while others were more or less equal to 3 or above 3, which implies that the respondents generally disagreed, were neutral or agreed with the statements.

### 5.4.2 Inferential Statistics

To evaluate whether the observed responses significantly differed from a neutral position, inferential statistics were used in the form of a one-sample t-test. This method tested whether the mean response for each item was statistically different from the theoretical neutral midpoint of 3 on the Likert scale. As outlined in Chapter 4 (§4.10.2), the t-test provided a way to assess the significance of respondents' agreement or disagreement with the statements.

#### *5.4.2.1 One-sample t-test and interpretation*

The one-sample t-test was conducted for each variable to determine whether the calculated mean scores were significantly different from the benchmark value of 3. This test was suitable given the scale used and the objective to establish whether responses leaned significantly towards agreement or disagreement. The formula applied was:

$$T = \frac{\overline{X} - \mu}{S/\sqrt{n}}$$

Where $\overline{X}$ is the mean score, μ is the assumed mean value (in this case, it equals to 3), S is the standard deviation of the scores, Xi's (where i = 1, 2, …30) and n is the sample size.

If the t-test result was statistically significant ($p < 0.05$) and the mean was less than 3, this indicated disagreement. If the mean was greater than 3, it indicated agreement. A non-significant result suggested a neutral stance. For example, Table 5.7a presents the results for variable B1: "The cultural and social challenges hinder the adoption of Green ICT in the organisation". The calculated mean score was 3.3 (standard deviation = 1.1), with a t-value of 4.1 and p-value = 0.000. Since this result was both statistically significant and greater than 3, it indicated that the respondents agreed with the statement.

The following section presents the analysis and results for section B, which focuses on the primary challenges to Green ICT adoption (Green IT Context).

## 5.5 ANALYSIS AND RESULTS OF SECTION B: PRIMARY CHALLENGES TO GREEN ICT ADOPTION (GREEN IT CONTEXT)

This section presents the statistical analysis of section B of the questionnaire, which aligns with the primary objective of the study. This section of the questionnaire consisted of 15 variables. During this analysis phase, these 15 variables were categorised under each of the three categories of the TOE framework, namely technology, organisation and environment.

### 5.5.1 Primary research objective:

- ***To identify the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT.***

The analysis is grounded in Construct 1: Green IT Context, as defined in the GITAM framework, which was described in Chapter 3 (§3.9.2). This construct incorporates the three contextual dimensions: technological, organisational and environmental, drawn from the TOE framework (Tornatzky & Fleischer, 1990), which serves as a foundational component within GITAM.

To evaluate this objective, both descriptive statistics (mean and standard deviation) and inferential statistics (one-sample t-tests) were applied, as described in Chapter 4 (§4.10.2). The one-sample t-test assessed whether the mean responses for each variable significantly differed from the neutral reference value of 3 on a five-point Likert scale. This approach offers a quantitative perspective on how employees perceive the contextual challenges impacting Green ICT adoption within Organisation A.

Table 5.7 below presents the complete descriptive and inferential statistics for each variable in section B, including Likert scale response distributions, mean scores, standard deviations and one-sample t-test results. This table provides a detailed overview of employees' perceptions regarding the contextual challenges and barriers influencing the adoption of Green ICT in Organisation A.

**Table 5.7: Descriptive and inferential results: The primary challenges encountered in transitioning to green ICT**

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| B1 | Organisational | 12 (5.85) | 43 (20.98) | 45 (21.95) | 77 (37.56) | 28 (13.66) | 3.3 | 1.1 | 4.1 (.000) | Reject |
| B2 | Organisational | 12 (5.85) | 28 (13.66) | 26 (12.68) | 96 (46.83) | 43 (20.98) | 3.6 | 1.1 | 8.0 (.000) | Reject |
| B3 | Environmental | 3(1.46) | 18 (8.78) | 40 (19.51) | 102 (49.76) | 42 (20.49) | 3.8 | .9 | 12.3 (.000) | Reject |
| B4 | Organisational | 19 (9.27) | 53 (25.85) | 43 (20.98) | 61 (29.76) | 29 (14.15) | 3.1 | 1.2 | 1.6 (.055) | Reject |
| B5 | Organisational | 14 (6.83) | 48 (23.41) | 46 (22.44) | 73 (35.61) | 24 (11.71) | 3.2 | 1.1 | 2.8 (.003) | Reject |
| B6 | Organisational | 2 (0.98) | 6 (2.93) | 14 (6.83) | 71 (34.63) | 112 (54.63) | 4.4 | .8 | 24.3 (.000) | Reject |
| B7 | Organisational | 14 (6.83) | 68 (33.17) | 46 (22.44) | 55 (26.83) | 22 (10.73) | 3.0 | 1.1 | 0.2 (.427) | **Accept** |
| B8 | Organisational | 10 (4.88) | 46 (22.44) | 64 (31.22) | 63 (30.73) | 22 (10.73) | 3.2 | 1.05 | 2.7 (.004) | Reject |
| B9 | Organisational | 7 | 19 | 22 | 94 | 63 | 3.9 | 1.0 | 12.5 | Reject |

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | |
| | | (3.41) | (9.27) | (10.73) | (45.85) | (30.73) | | | (.000) | |
| B10 | Environmental | 6 (2.93) | 26 (12.68) | 49 (23.90) | 87 (42.44) | 37 (18.05) | 3.6 | 1.0 | 8.4 (.000) | Reject |
| B11 | Environmental | 9 (4.39) | 24 (11.71) | 41 (20.00) | 102 (49.76) | 29 (14.15) | 3.6 | 1.0 | 8.1 (.000) | Reject |
| B12 | Environmental | 10 (4.88) | 32 (15.61) | 47 (22.93) | 78 (38.05) | 38 (18.54) | 3.5 | 1.1 | 6.4 (.000) | Reject |
| B13 | Technological | 9 (4.39) | 47 (22.93) | 56 (27.32) | 64 (31.22) | 29 (14.15) | 3.3 | 1.1 | 3.6 (.000) | Reject |
| B14 | Technological | 6 (2.93) | 25 (12.20) | 46 (22.44) | 74 (36.10) | 54 (26.34) | 3.7 | 1.1 | 9.4 (.000) | Reject |
| B15 | Technological | 11 (5.37) | 39 (19.02) | 74 (36.10) | 57 (27.80) | 24 (11.71) | 3.2 | 1.1 | 2.9 (.002) | Reject |

**Source:** Author's Compilation (2025)

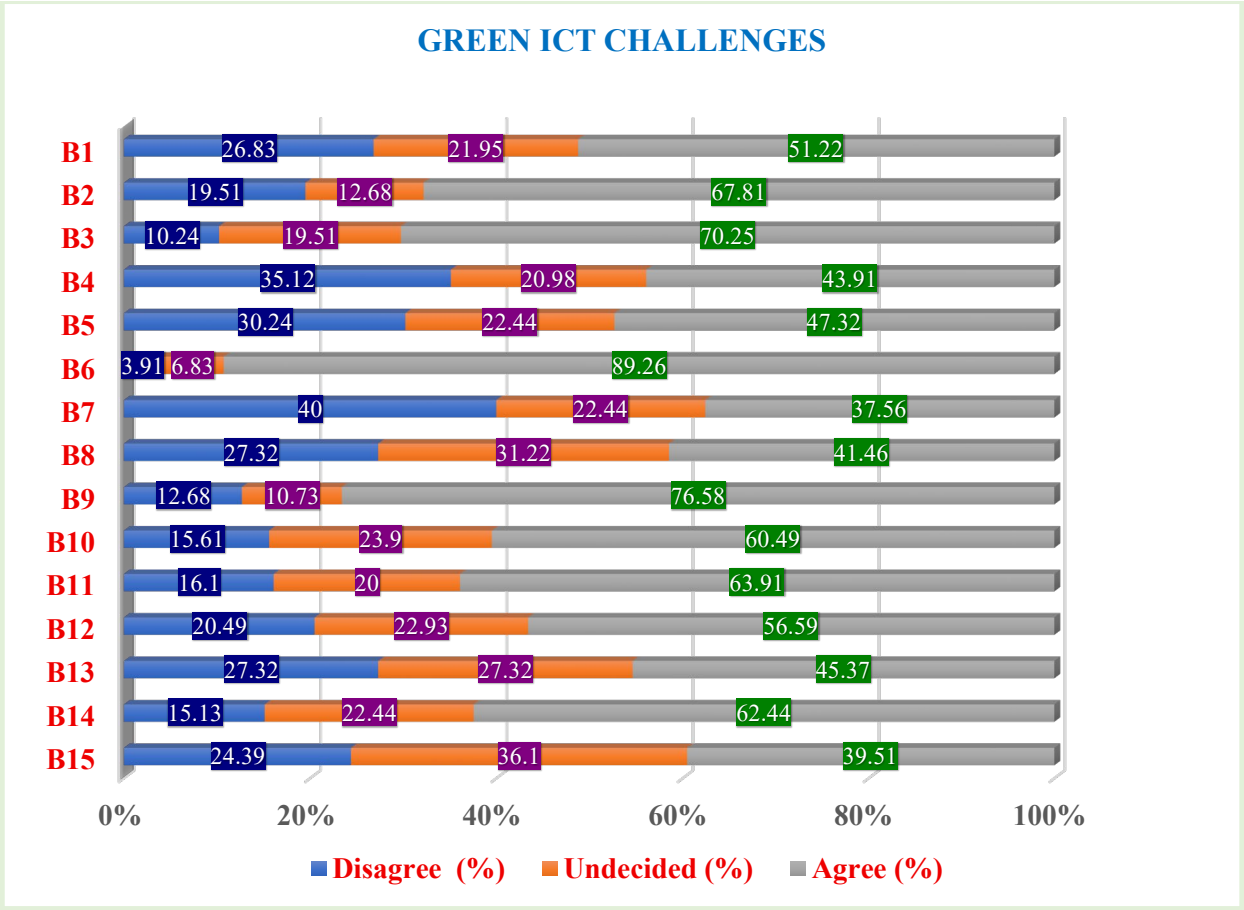


**Figure 5.8:** Green ICT challenges in Organisation A

**Source:** Author's Compilation (2025)

The following section focuses on the technological factors identified within the primary challenges to Green ICT adoption, as measured in section B of the questionnaire.

#### *5.5.1.1 Primary objective: TOE Category 1 – TECHNOLOGY*

This section analyses the technological factors influencing the adoption of Green ICT within Organisation A, aligned with Construct 1: Green IT Context from the GITAM framework (§3.9.2) (Hejri et al., 2022). These factors were operationalised through selected variables in section B of the questionnaire and reflect the technological contextual factors of Financial Motivations**;** Strategic and Operational Excellence and Regulation, Risk and Compliance**.**

The analysis focuses on the following three variables, which represent contextual factors grouped under the technological dimension of the TOE framework.

- *B13 – Technological Infrastructure; B14 – Financial Burden and B15 – Departmental Readiness*

Table 5.8 presents the descriptive statistics, the one-sample t-test results for category 1 (Technological Factors) and the results of the Likert scale ranges. This is followed by the analysis and results from the collected data.

**Table 5.8: Results for technological factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| B13 | The organisation's technological infrastructure is adequately prepared for a transition to Green ICT. | 9 (4.39) | 47 (22.93) | 56 (27.32) | 64 (31.22) | 29 (14.15) | 3.3 | 1.1 | 3.6 (.000) | Reject |
| B14 | The financial burden of implementing Green ICT is a challenge in my department. | 6 (2.93) | 25 (12.20) | 46 (22.44) | 74 (36.10) | 54 (26.34) | 3.7 | 1.1 | 9.4(.000) | Reject |
| B15 | My department is ready to implement Green ICT practices compared to other departments. | 11 (5.37) | 39 (19.02) | 74 (36.10) | 57 (27.80) | 24 (11.71) | 3.2 | 1.1 | 2.9(.002) | Reject |

**Source:** Author's Compilation (2025)

***Variable B13***: This variable reflects the adequacy of technological infrastructure in Organisation A. The results show that the majority of respondents (45.37%, n=93) agreed that the organisation's technological infrastructure is adequately prepared for a transition to green; a small percentage (27.32%, n=56) of respondents disagreed whilst the remainder (27.32%, n=56) were undecided.

***Variable B14***: This variable reflects the financial motivations of implementing Green ICT in Organisation A. The results show that the majority of respondents (62.44%, n=128) agreed that the financial burden of implementing Green ICT is a challenge in their departments. A small percentage (15.13%, n=31) of respondents disagreed whilst the remainder (22.44%, n = 46) were undecided.

***Variable B15***: This variable reflects the readiness to implement Green ICT practices in Organisation A. The results show that the majority of respondents (39.51%, n=81) agreed that their department is ready to implement Green ICT practices compared to other departments. A small percentage (24.39%, n=50) of respondents disagreed whilst the remainder (36.10%, n = 74) were undecided.

All three variables recorded mean values above the neutral benchmark of 3 and were statistically significant at the 5% level ($p < 0.05$). Standard deviations were consistent at 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the technological dimension as assessed in Section B of the questionnaire. The following section focuses on the organisational factors identified within the primary challenges to Green ICT adoption, as measured in Section B of the questionnaire.

#### *5.5.1.2 Primary objective: TOE Category 2 – ORGANISATION*

This section analyses the organisational factors influencing the adoption of Green ICT within Organisation A, aligned with Construct 1: Green IT Context from the GITAM framework (§3.9.2) (Hejri et al., 2022). These factors were operationalised through selected variables in section B of the questionnaire and reflect the organisational contextual factors of organisational identity, culture, talent, stakeholder engagement and partnership; as defined within Construct 1: Green IT Context. The analysis focuses on the following eight variables, which represent contextual factors grouped under the organisational dimension of the TOE framework.

- *B1 – Cultural and Social Challenges; B2 – Communication and Knowledge Gaps; B4 – Employees' Reluctance to Change; B5 – Organisational Norms; B6 – Leadership Support; B7 – Employee Understanding; B8 – Communication Strategies and B9 – Lack of Training.*

Table 5.9 presents the descriptive statistics, the one-sample t-test results for category 2 (Organisational factors) and the results of the Likert scale ranges. This is followed by the analysis and results from the collected data.

**Table 5.9: Results for the Organisational factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| B1 | The cultural and social challenges hinder the adoption of Green ICT in the organisation. | 12 (5.85) | 43 (20.98) | 45 (21.95) | 77 (37.56) | 28 (13.66) | 3.3 | 1.1 | 4.1 (.000) | Reject |
| B2 | The knowledge and communication challenges hinder the adoption of Green ICT in the organisation. | 12 (5.85) | 28 (13.66) | 26 (12.68) | 96 (46.83) | 43 (20.98) | 3.6 | 1.1 | 8.0 (.000) | Reject |
| B4 | The employees' reluctance to change is a challenge in adopting Green ICT within the organisation. | 19 (9.27) | 53 (25.85) | 43 (20.98) | 61 (29.76) | 29 (14.15) | 3.1 | 1.2 | 1.6 (.055) | Reject |
| B5 | The cultural norms within the organisation limit the effectiveness of Green ICT initiatives. | 14 (6.83) | 48 (23.41) | 46 (22.44) | 73 (35.61) | 24 (11.71) | 3.2 | 1.1 | 2.8 (.003) | Reject |
| B6 | The leadership support is essential to overcoming cultural resistance to Green ICT implementation. | 2 (0.98) | 6 (2.93) | 14 (6.83) | 71 (34.63) | 112 (54.63) | 4.4 | .8 | 24.3 (.000) | Reject |
| B7 | There is sufficient understanding of Green ICT principles among employees in the organisation. | 14 (6.83) | 68 (33.17) | 46 (22.44) | 55 (26.83) | 22 (10.73) | 3.0 | 1.1 | 0.2 (.427) | **Accept** |
| B8 | The current communication | 10 (4.88) | 46 (22.44) | 64 (31.22) | 63 | 22 (10.73) | 3.2 | 1.05 | 2.7 (.004) | Reject |

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| | strategies promote Green ICT awareness effectively in the organisation. | | | | (30.73) | | | | | |
| B9 | The lack of Green ICT training is a significant barrier in the transition process. | 7 (3.41) | 19 (9.27) | 22 (10.73) | 94 (45.85) | 63 (30.73) | 3.9 | 1.0 | 12.5 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable B1*:** This variable reflects the influence of cultural and social challenges on the adoption of green ICT in Organisation A. The results show that the majority of respondents (51,22%, n=105) agreed that cultural and social challenges hinder the adoption of Green ICT in the organisation. A smaller percentage (26,83%, n=55) of respondents disagreed, whilst the remainder (21,95%, n=45) were undecided.

***Variable B2*:** This variable reflects the impact of knowledge and communication challenges on the adoption of Green ICT in Organisation A. The results show that the majority of respondents (67,81%, n=139) agreed that knowledge and communication challenges hinder the adoption of Green ICT in the organisation. A small percentage (19,51%, n=40) of respondents disagreed, whilst the remainder (12,68%, n=26) were undecided.

***Variable B4:*** This variable reflects the challenge posed by employees' reluctance to change in adopting Green ICT in Organisation A. The results show that most (43.91%, n=90) of respondents agreed that employees' resistance to change is a challenge. A relatively large proportion (35.12%, n=72) of respondents disagreed, whilst the remainder (20.98%, n=43) were undecided.

***Variable B5:*** This variable reflects the influence of cultural norms on the effectiveness of Green ICT initiatives in Organisation A. The results show that a large number (47.32%, n=97) of respondents agreed that cultural norms within the organisation limit Green ICT effectiveness. A considerable portion (30.24%, n=62) of respondents disagreed, whilst the remainder (22.44%, n=46) were undecided.

***Variable B6:*** This variable reflects the importance of leadership support in overcoming cultural resistance to Green ICT implementation in Organisation A. The results show that the majority of respondents (89.26%, n=183) agreed that leadership support is essential. Only a small

number (3.91%, n=8) of respondents disagreed, whilst the remainder (6.83%, n=14) were undecided.

***Variable B7:*** This variable reflects the level of understanding of Green ICT principles among employees in Organisation A. The results show that a modest number (37.56%, n=77) of respondents agreed that there is sufficient understanding. A notable proportion (40.00%, n=82) of respondents disagreed, whilst the remainder (22.44%, n=46) were undecided.

***Variable B8:*** This variable reflects perceptions of the organisation's communication strategies in promoting Green ICT awareness. The results show that most (41.46%, n=85) of the respondents agreed that current communication strategies are effective. A considerable portion (27.32%, n=56) of respondents disagreed, whilst the remainder (31.22%, n=64) were undecided.

***Variable B9:*** This variable reflects the extent to which a lack of Green ICT training is seen as a barrier in Organisation A. The results show that the majority of respondents (76.58%, n=157) agreed that lack of training is a significant barrier. A small proportion (12.68%, n=26) of respondents disagreed, whilst the remainder (10.73%, n=22) were undecided.

All variables recorded mean scores at or above the neutral benchmark of 3, except for B7, which scored exactly 3. The majority of variables were statistically significant ($p < .05$), with the exception of B7 ($p = .427$), which was not statistically significant. Standard deviations ranged from 0.8 to 1.2, indicating moderate variability in responses. The results present the statistical patterns associated with the organisational contextual dimension, as measured through Section B of the questionnaire. The following section focuses on the environmental factors identified as primary challenges influencing the adoption of Green ICT, based on responses from Section B of the questionnaire.

#### *5.5.1.3 Primary objective: TOE Category 3 – ENVIRONMENT*

This section analyses the environmental factors influencing the adoption of Green ICT within Organisation A. These factors are aligned with Construct 1: Green IT Context, as defined in the GITAM framework (§3.9.2) (Thomson & Van Belle, 2015). The selected variables from Section B of the questionnaire reflect external environmental considerations such as sustainability, market dynamics and social responsibility—key elements of the TOE framework's environmental dimension. The analysis focuses on the following four variables; all grouped under the environmental category of the TOE framework:

- *B3 – Market and Demand Challenges; B10 – Customer Expectations; B11 – Market Demand and B12 – Industry Competition.*

Table 5.10 presents the descriptive statistics, one-sample t-test results for category 3 (Environmental Factors) and Likert scale distributions. This is followed by an interpretation of the data to assess how each factor contributes to or hinders Green ICT adoption within Organisation A.

**Table 5.10: Results for the environmental factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| B3 | The market and demand challenges hinder the adoption of Green ICT in the Organisation. | 3 (1.46) | 18 (8.78) | 40 (19.51) | 102 (49.76) | 42 (20.49) | 3.8 | .9 | 12.3 (.000) | Reject |
| B10 | The customer expectations for Green ICT influence the organisation's strategic planning. | 6 (2.93) | 26 (12.68) | 49 (23.90) | 87 (42.44) | 37 (18.05) | 3.6 | 1.0 | 8.4 (.000) | Reject |
| B11 | A lack of market demand for Green ICT services hinders its adoption within the organisation. | 9 (4.39) | 24 (11.71) | 41 (20.00) | 102 (49.76) | 29 (14.15) | 3.6 | 1.0 | 8.1 (.000) | Reject |
| B12 | The competition in the telecommunications industry impacts Green ICT adoption within my department. | 10 (4.88) | 32 (15.61) | 47 (22.93) | 78 (38.05) | 38 (18.54) | 3.5 | 1.1 | 6.4 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable B3:*** This variable reflects the influence of market and demand challenges on the adoption of Green ICT in Organisation A. The results show that the majority of respondents (70.25%, n=144) agreed that market and demand challenges hinder the adoption of Green ICT in the organisation. A smaller percentage (10.24%, n=21) disagreed, whilst the remainder ( 19.51%, n=40) were undecided.

***Variable B10*:** This variable reflects the role of customer expectations in shaping the organisation's strategic planning towards Green ICT. The results show that the majority of

respondents (60.49%, n=124) agreed that customer expectations influence the organisation's Green ICT strategy. A small total (15.61%, n=32) of respondents disagreed, whilst the remainder (23.90%, n=49) were undecided.

***Variable B11*:** This variable reflects whether a lack of market demand hinders Green ICT adoption in Organisation A. The results show that the majority of respondents (63.91%, n=131) agreed that the absence of market demand for Green ICT services is a barrier to adoption. A minority (16.10%, n=33) of respondents disagreed, whilst the remainder (20.00%, n=41) were undecided.

***Variable B12*:** This variable reflects the impact of industry competition on Green ICT adoption in the organisation. The results show that the majority of respondents (56.59%, n=116) agreed that competition within the telecommunications industry influences Green ICT implementation. A modest total (20.49%, n=42) of respondents disagreed, whilst the remainder (22.93%, n=47) were undecided.

All variables recorded mean scores above the neutral reference point of 3 and were statistically significant at the 5% level ($p < .05$). Standard deviations ranged from 0.9 to 1.1, indicating moderate variability in respondents' responses. The results reflect the statistical outputs associated with external environmental factors as measured in Section B of the questionnaire.

### 5.5.2 Summary of Section B: Green IT context

Section B analysed the contextual factors influencing Green ICT adoption in Organisation A, directly addressing the primary objective of the study—to identify the main challenges faced by a South African telecommunication organisation in transitioning to Green ICT. The analysis was based on Construct 1 of the GITAM framework (§3.9.2), (Molla, 2008), with variables grouped under the Technology-Organisation-Environment (TOE) dimensions: technological (B13–B15), organisational (B1, B2, B4–B9) and environmental (B3, B10–B12), as detailed in Chapter 3. These were operationalised through Section B questionnaire items and statistically analysed using one-sample t-tests (§4.10.2). Most variables produced mean scores above the neutral reference point of 3 and were statistically significant at either the 5% or 1% level, reflecting general agreement with the associated statements. One item (B4) yielded a borderline result (mean = 3.1, $p = 0.055$), while another (B7) returned a neutral score (mean = 3.0, $p = .427$).

These results offer statistical evidence of the role played by contextual (technological, organisational and environmental) factors in shaping Green ICT adoption. The consistent rejection of the null hypothesis across most items contributes to the assessment of hypothesis H1, which posits that the current state of Green ICT adoption in Organisation A is suboptimal. An analytical evaluation of this hypothesis is presented later in this chapter, with integrated findings and recommendations provided in Chapter 6.

## 5.6 ANALYSIS AND RESULTS OF SECTION C: CURRENT STATE OF GREEN ICT ADOPTION (GREEN IT CONTEXT AND DRIVERS)

This section presents the statistical analysis of Section C of the questionnaire, which aligns with the secondary objective 1 of the study. This section of the questionnaire consisted of 15 variables. During this analysis phase, these 15 variables were categorised under each of the three categories of the TOE framework, namely technological, organisational and environmental.

### 5.6.1 Secondary research objective 1:

- ***To evaluate the current state of Green ICT adoption within Organisation A.***

The analysis is based on Construct 1: Green IT Context and Construct 3: Drivers of Green Information Technology, as defined in the GITAM framework, which was described in Chapter 3 (§3.9.2) (Hejri et al., 2022) and (§3.9.4) (Cordero et al., 2023). These constructs explore both the contextual landscape and the enabling factors that influence the implementation of Green ICT initiatives. The TOE framework provides a structured analytical lens for categorising and interpreting the data across the technological, organisational and environmental categories. To evaluate this objective, both descriptive statistics (mean and standard deviation) and inferential statistics (one-sample t-tests) were applied, as outlined in Chapter 4 (§4.10.2). The one-sample t-test assessed whether the mean scores for each item significantly deviated from the neutral reference point of 3 on a five-point Likert scale. This approach provides a statistical indication of how employees perceive the implementation and effectiveness of Green ICT practices within Organisation A.

Table 5.11 presents the descriptive and inferential statistics for each variable in Section C, including Likert scale response distributions, mean scores, standard deviations and one-sample t-test results. This table provides a comprehensive overview of employee perceptions regarding the current state of Green ICT adoption within Organisation A.

**Table 5.11: Descriptive and inferential statistical results: Current state of Green ICT adoption within Organisation A**

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| C1 | Technological | 3 (1.46) | 13 (6.34) | 46 (22.44) | 91 (44.39) | 52 (25.37) | 3.9 | .9 | 13.35 (.000) | Reject |
| C2 | Organisational | 22 (10.73) | 57 (27.80) | 70 (34.15) | 39 (19.02) | 17 (8.29) | 2.9 | 1.1 | -1.8 (.039) | Reject |
| C3a | Technological | 17 (8.29) | 28 (13.66) | 68 (33.17) | 67 (32.68) | 25 (12.20) | 3.3 | 1.1 | 3.5 (.000) | Reject |
| C3b | Technological | 10 (4.88) | 34 (16.59) | 59 (28.78) | 81 (39.51) | 21 (10.24) | 3.3 | 1.0 | 4.7 (.000) | Reject |
| C3c | Technological | 11 (5.37) | 28 (13.66) | 80 (39.02) | 57 (27.80) | 29 (14.15) | 3.3 | 1.0 | 4.3 (.000) | Reject |
| C3d | Technological | 13 (6.34) | 31 (15.12) | 77 (37.56) | 68 (33.17) | 16 (7.80) | 3.2 | 1.0 | 3.0 (.000) | Reject |
| C3e | Technological | 7 (3.41) | 12 (5.85) | 57 (27.80) | 81(39.51) | 48 (23.41) | 3.7 | 1.0 | 10.6 (.000) | Reject |
| C3f | Technological | 3 (1.46) | 11 (5.37) | 21 (10.24) | 82 (40.00) | 88 (42.93) | 4.2 | .9 | 18.2 (.000) | Reject |
| C3g | Technological | 3 (1.46) | 12 (5.85) | 33 (16.10) | 100 (48.78) | 57 (27.80) | 4.0 | .9 | 15.2 (.000) | Reject |
| C3h | Environmental | 7 (3.41) | 33 (16.10) | 88 (42.993) | 58 (18.29) | 19 (9.27) | 3.2 | .9 | 3.6 (.000) | Reject |
| C3i | Environmental | 8 (3.90) | 29 (14.15) | 70 (34.15) | 72 (35.12) | 26 (12.68) | 3.4 | 1.0 | 5.5 (.000) | Reject |
| C4 | Organisational | 17 (8.29) | 54 (26.34) | 56 (27.32) | 60 (29.27) | 18 (8.78) | 3.0 | 1.1 | 0.5 (.308) | **Accept** |
| C5 | Organisational | 13 (6.34) | 53 (25.85) | 71 (34.63) | 56 (27.32) | 12 (5.85) | 3.0 | 1.0 | 0.1 (.473) | Accept |
| C6 | Organisational | 16 (7.80) | 64 (31.22) | 69 (33.66) | 41 (20.00) | 15 (7.32) | 2.9 | 1.05 | -1.7 (.049) | Reject |
| C7 | Organisational | 19 | 68 | 68 | 39 | 11 | 2.8 | 1.0 | -3.0 | Reject |

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | |
| | | (9.27) | (33.17) | (33.17) | (19.02) | (5.37) | | | (.001) | |

**Source:** Author's Compilation (2025)

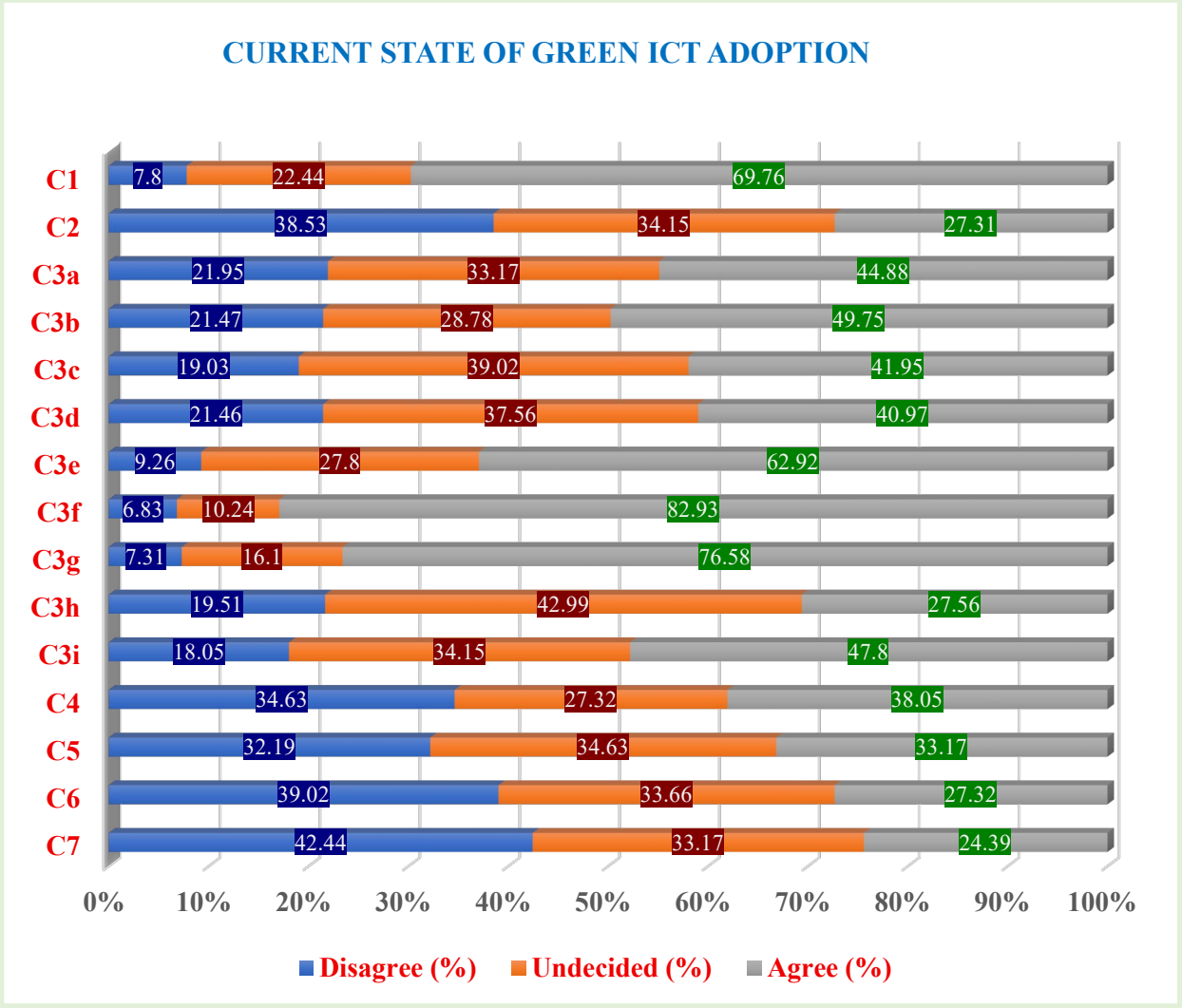


**Figure 5.9:** Current state of Green ICT adoption in Organisation A

**Source:** Author's Compilation (2025)

The following section focuses on the technological factors identified in relation to the current state of Green ICT adoption, as assessed in Section C of the questionnaire.

#### *5.6.1.1 Secondary Objective 1: TOE Category 1 – TECHNOLOGY*

This section analyses the technological factors influencing the current state of Green ICT adoption within Organisation A. These factors are aligned with Construct 1: Green IT Context and Construct 3: Drivers of Green IT, as defined in the GITAM framework (§3.9.2) (Hejri et al., 2022) and (§3.9.4) (Cordero et al., 2023). The selected variables from Section C of the questionnaire reflect a combination of technological readiness (Construct 1: Green IT Context) and internal technological drivers (Construct 3: Drivers of Green IT).

The analysis focuses on the following eight variables; all grouped under the technological category of the TOE framework:

- *C1 – Organisational Adoption (Construct 1); C3a – Energy Efficiency (Construct 3); C3b – Sustainable Design and Production (Construct 3); C3c – E-waste Management (Construct 3); C3d – Renewable Energy (Construct 3); C3e – Virtualisation (Construct 3); C3f – Remote Work (Construct 3) and C3g – Network Efficiency (Construct 3).*

Table 5.12 presents the descriptive statistics, one-sample t-test results for category 1 (Technological Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Green ICT implementation within the organisation.

**Table 5.12: Results for technological factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| C1 | Organisation A's Green ICT practices reduce the environmental impact. | 3 (1.46) | 13 (6.34) | 46 (22.44) | 91 (44.39) | 52 (25.37) | 3.9 | .9 | 13.35 (.000) | Reject |
| C3a | Energy efficiency practices in my department are effective. | 17 (8.29) | 28 (13.66) | 68 (33.17) | 67 (32.68) | 25 (12.20) | 3.3 | 1.1 | 3.5 (.000) | Reject |
| C3b | Sustainable design and production practices in my department are effective. | 10 (4.88) | 34 (16.59) | 59 (28.78) | 81 (39.51) | 21 (10.24) | 3.3 | 1.0 | 4.7 (.000) | Reject |
| C3c | E-waste management practices in my department are effective. | 11 (5.37) | 28 (13.66) | 80 (39.02) | 57 (27.80) | 29 (14.15) | 3.3 | 1.0 | 4.3 (.000) | Reject |

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| C3d | Renewable energy practices in my department are effective. | 13 (6.34) | 31 (15.12) | 77 (37.56) | 68 (33.17) | 16 (7.80) | 3.2 | 1.0 | 3.0 (.000) | Reject |
| C3e | Virtualisation and cloud computing practices in my department are effective. | 7 (3.41) | 12 (5.85) | 57 (27.80) | 81 (39.51) | 48 (23.41) | 3.7 | 1.0 | 10.6 (.000) | Reject |
| C3f | Remote work practices in my department are effective. | 3 (1.46) | 11 (5.37) | 21 (10.24) | 82 (40.00) | 88 (42.93) | 4.2 | .9 | 18.2 (.000) | Reject |
| C3g | Network efficiency practices in my department are effective. | 3 (1.46) | 12 (5.85) | 33 (16.10) | 100 (48.78) | 57 (27.80) | 4.0 | .9 | 15.2 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable C1*:** This variable reflects the perception that Organisation A's Green ICT practices reduce environmental impact. The results show that the majority of respondents (69.76%, n=143) agreed that the organisation's practices help reduce environmental harm. A small percentage (7.80%, n=16) disagreed, whilst the remainder (22.44%, n=46) were undecided.

***Variable C3a*:** This variable reflects the effectiveness of energy efficiency practices within departments. The results show that most (44.88%, n=92) of respondents agreed that these practices are effective, while the least number (21.95%, n=45) disagreed. A notable number of respondents (33.17%, n=68) were undecided.

***Variable C3b*:** This variable reflects the effectiveness of sustainable design and production practices within departments. Most respondents (49.75%, n=102) agreed that such practices are effective, while the minority (21.47%, n=44) disagreed. The remainder (28.78%, n=59) were undecided.

***Variable C3c*:** This variable reflects the effectiveness of e-waste management practices within departments. The results indicate that most respondents (41.95% (n=86) agreed that these practices are effective. A smaller group (19.03%, n=39) disagreed, while the remainder (39.02%, n=80) were undecided.

***Variable C3d*:** This variable assesses the effectiveness of renewable energy practices within departments. The findings show that most respondents (40.97%, n=84) agreed with the

statement. A significant portion (21.46%, n=44) disagreed, and the remainder (37.56% n=77) were undecided.

***Variable C3e*:** This variable represents the effectiveness of virtualisation and cloud computing practices. Most respondents (62.92%, n=129) agreed that these practices are effective, while a small number (9.26%, n=19) disagreed. The rest (27.80%, n=57) remained undecided.

***Variable C3f*:** This variable reflects the effectiveness of remote work practices within departments. The results reveal strong agreement, with most (82.93%, n=170) respondents indicating these practices are effective. A very small number (6.83%, n=14) disagreed, while the remainder (10.24%, n=21) were undecided.

***Variable C3g*:** This variable evaluates the effectiveness of network efficiency practices. A majority of respondents (76.58%, n=157) agreed that these practices are effective. Only a few (7.31%, n=15) disagreed, and the remainder (16.10%, n=33) were undecided.

All variables recorded mean values above the neutral benchmark of 3 and were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the technological category as assessed in Section C of the questionnaire. The following section focuses on the organisational factors influencing the current state of Green ICT adoption, as assessed in Section C of the questionnaire.

#### *5.6.1.2 Secondary objective 1: TOE Category 2 – ORGANISATION*

This section analyses the organisational factors influencing the current state of Green ICT adoption within Organisation A. These factors are aligned with Construct 1: Green IT Context and Construct 3: Drivers of Green IT, as defined in the GITAM framework (§3.9.2) (Hejri et al., 2022) and (§3.9.4) (Cordero et al., 2023). The selected variables from Section C of the questionnaire reflect a combination of organisational readiness (Construct 1: Green IT Context) and internal organisational drivers (Construct 3: Drivers of Green IT). The analysis focuses on the following five variables; all grouped under the organisational category of the TOE framework:

- *C2 – Departmental Readiness (Construct 1); C4 – Organisational Culture (Construct 3); C5 – Employee Skills and Training (Construct 3); C6 – Monitoring and Evaluation (Construct 3) and C7 – Training and Development Support (Construct 3).*

Table 5.13 presents the descriptive statistics, one-sample t-test results for category 2 (Organisational Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Green ICT implementation within the organisation.

**Table 5.13: Results for the organisational factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| C2 | The Green ICT initiatives in my department are regularly reviewed and updated. | 22 (10.73) | 57 (27.80) | 70 (34.15) | 39 (19.02) | 17 (8.29) | 2.9 | 1.1 | -1.8 (.039) | Reject |
| C4 | I am well-informed about the Green ICT policies and guidelines implemented by Organisation A. | 17 (8.29) | 54 (26.34) | 56 (27.32) | 60 (29.27) | 18 (8.78) | 3.0 | 1.1 | 0.5 (.308) | **Accept** |
| C5 | Organisation A provides sufficient resources to support the adoption of Green ICT practices in my department. | 13 (6.34) | 53 (25.85) | 71 (34.63) | 56 (27.32) | 12 (5.85) | 3.0 | 1.0 | 0.1 (.473) | **Accept** |
| C6 | Green ICT initiatives in my department are regularly monitored to assess their impact and effectiveness. | 16 (7.80) | 64 (31.22) | 69 (33.66) | 41 (20.00) | 15 (7.32) | 2.9 | 1.05 | -1.7 (.049) | Reject |
| C7 | Organisation A offers adequate training to employees to ensure successful implementation of Green ICT practices. | 19 (9.27) | 68 (33.17) | 68 (33.17) | 39 (19.02) | 11 (5.37) | 2.8 | 1.0 | -3.0 (.001) | Reject |

**Source:** Author's Compilation (2025)

***Variable C2*:** This variable reflects whether the Green ICT initiatives in departments are regularly reviewed and updated. The results show that a minority (27.31%, n=56) of respondents agreed that these initiatives are regularly reviewed. A notable percentage (38.53%, n=79) disagreed, whilst the remainder (34.15%, n=70) were undecided.

***Variable C4*:** This variable reflects whether respondents are well-informed about the Green ICT policies and guidelines implemented by Organisation A. The results show a significant number (38.05%, n=78) of respondents agreed that they are well-informed. A comparable percentage (34.63%, n=71) disagreed, whilst the remainder (27.32%, n=56) were undecided.

***Variable C5*:** This variable reflects whether Organisation A provides sufficient resources to support the adoption of Green ICT practices. The results show that a small number (33.17%, n=68) of respondents agreed that resources are sufficient. A similar portion (32.19%, n=66) disagreed, whilst the remainder (34.63%, n=71) were undecided.

***Variable C6*:** This variable reflects whether Green ICT initiatives in departments are regularly monitored to assess their impact and effectiveness. The results show a minority (27.32%, n=56) of respondents agreed that monitoring is consistently done. A significant percentage (39.02%, n=80) disagreed, while the remainder (33.66%, n=69) were undecided.

***Variable C7*:** This variable reflects whether Organisation A offers adequate training to employees to ensure successful implementation of Green ICT practices. The results show that a small percentage (24.39%, n=50) of respondents agreed that sufficient training is provided. A larger percentage (42.44%, n=87) disagreed, whilst the remainder (33.17%, n=68) were undecided.

All variables under the organisational category recorded mean values at or near the neutral benchmark of 3. The results for three variables (C2, C6 and C7) were statistically significant at the 5% level ($p < 0.05$), while two variables (C4 and C5) were not. Standard deviations ranged from 1.0 to 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the organisational category as assessed in Section C of the questionnaire. The following section focuses on the environmental factors influencing the current state of Green ICT adoption, as assessed in Section C of the questionnaire.

#### *5.6.1.3 Secondary objective 1: TOE Category 3 – ENVIRONMENT*

This section analyses the environmental factors influencing the current state of Green ICT adoption within Organisation A. These factors are aligned with Construct 3: Drivers of Green IT, as defined in the GITAM framework (§3.9.4) (Cordero et al., 2023). The selected variables from Section C of the questionnaire reflect external environmental drivers that influence Green ICT initiatives (Construct 3: Drivers of Green IT). The analysis focuses on the following two variables; both grouped under the environmental category of the TOE framework:

- *C3h – Green Standards and Policies (Construct 3) and C3i – Research and Innovation (Construct 3).*

Table 5.14 presents the descriptive statistics, one-sample t-test results for category 3 (Environmental Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Green ICT implementation within the organisation.

**Table 5.14: Results for the environmental factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| C3h | Green standards and policies in my department are effective. | 7 (3.41) | 33 (16.10) | 88 (42.993) | 58 (18.29) | 19 (9.27) | 3.2 | .9 | 3.6 (.000) | Reject |
| C3i | Research and innovation practices in my department are effective. | 8 (3.90) | 29 (14.15) | 70 (34.15) | 72 (35.12) | 26 (12.68) | 3.4 | 1.0 | 5.5 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable C3h***: This variable reflects whether the green standards and policies in departments are effective. The results show that a small number (27.56%, n=77) of respondents agreed that these policies are effective. A smaller percentage (19.51%, n=40) disagreed, whilst the majority (42.99%, n=88) were undecided.

***Variable C3i***: This variable reflects whether research and innovation practices in departments are effective. The results show that the majority (47.80%, n=98) of respondents agreed that such practices are effective. A smaller portion (18.05%, n=37) disagreed, whilst the remainder (34.15% n=70) were undecided.

All variables under the environmental category recorded mean values above the neutral benchmark of 3. The results for both variables (C3h and C3i) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.0, indicating moderate

variability in responses. These results reflect the descriptive statistical outputs for the environmental category as assessed in Section C of the questionnaire.

### 5.6.2 Summary of Section C: Green IT Context and Drivers

Section C analysed the current adoption and implementation of Green ICT practices within Organisation A, directly addressing the secondary objective 1—to evaluate the current state of Green ICT adoption. The analysis was based on Construct 1 and Construct 3 of the GITAM framework (§3.9.2) (Hejri et al., 2022) and (§3.9.4) (Cordero et al., 2023) With variables grouped under the TOE framework dimensions: technological (C1, C3a to C3g), organisational (C2, C4 to C7) and environmental (C3h and C3i), as described in Chapter 3. These were operationalised through Section C questionnaire items and statistically analysed using one-sample t-tests (§4.10.2). The majority of variables recorded mean scores at or above the neutral benchmark of 3 and were statistically significant at the 5 percent or 1 percent level, indicating general agreement with the corresponding statements. Two organisational variables (C4 and C5) were not statistically significant, while the remaining variables produced p-values below 0.05. The lowest score was observed for variable C7 (mean = 2.8, $p = .001$), indicating weaker agreement on training support. In contrast, the highest score was found for variable C3f (mean = 4.2, $p < .001$), reflecting strong agreement on the effectiveness of remote work practices.

These findings provide statistical evidence that green IT context and internal drivers, as categorised under technological, organisational and environmental factors, influence the implementation of Green ICT within the organisation. The consistent rejection of the null hypothesis in most cases supports hypothesis H3, which proposes that employee perception and participation significantly affect the success of Green ICT implementation. A detailed discussion of this hypothesis follows later in the chapter, with consolidated findings and recommendations presented in Chapter 6.

## 5.7 ANALYSIS AND RESULTS OF SECTION D: GREEN ICT READINESS (CHALLENGES AND BARRIERS)

This section presents the statistical analysis of Section D of the questionnaire, which aligns with secondary objective 2 of the study. This section of the questionnaire consisted of 17 variables. During this analysis phase, these 17 variables were categorised under each of the

three categories of the TOE framework, namely technological, organisational and environmental.

### 5.7.1 Secondary research objective 2:

- ***To investigate the challenges and barriers that impact Organisation A's transition to Green ICT.***

The analysis is based on Construct 2: Green Information Technology Readiness, as defined in the GITAM framework and discussed in Chapter 3 (§3.9.3). This construct examines the preparedness of both the organisation and its surrounding environment for adopting Green ICT, focusing on internal and external challenges that may hinder successful implementation. The TOE framework provides a structured analytical lens for categorising and interpreting the data across the technological, organisational and environmental categories. To evaluate this objective, both descriptive statistics (mean and standard deviation) and inferential statistics (one-sample t-tests) were applied, as outlined in Chapter 4 (§4.10.2). The one-sample t-test assessed whether the mean scores for each item significantly deviated from the neutral reference point of 3 on a five-point Likert scale. This approach provides a statistical indication of how employees perceive the readiness and barriers affecting Green ICT adoption within Organisation A.

Table 5.15 presents the descriptive and inferential statistics for each variable in Section D, including Likert scale response distributions, mean scores, standard deviations and one-sample t-test results. This table provides a comprehensive overview of employee perceptions regarding the readiness of the organisation and the challenges hindering its transition to Green ICT.

**Table 5.15: Descriptive and inferential statistical results: Readiness and barriers affecting Green ICT adoption within Organisation A**

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| D1 | Organisational | 7 (3.41) | 24 (11.71) | 51 (24.88) | 100 (48.78) | 23 (11.22) | 3.5 | 1.0 | 7.9 (.000) | Reject |
| D2 | Organisational | 7 (3.41) | 33 (16.10) | 57 (27.80) | 78 (38.05) | 30 (14.63) | 3.4 | 1.0 | 6.1 (.000) | Reject |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| D3 | Technological | 8 (3.90) | 30 (14.63) | 49 (23.90) | 89 (43.41) | 29 (14.15) | 3.5 | 1.0 | 6.8 (.000) | Reject |
| D4 | Organisational | 4 (1.95) | 18 (8.78) | 46 (22.44) | 78 (38.05) | 59 (28.78) | 3.8 | 1.0 | 11.8 (.000) | Reject |
| D5 | Environmental | 8 (3.90) | 48 (23.41) | 71 (34.63) | 56 (27.32) | 22 (10.73) | 3.2 | 1.0 | 2.4 (.008) | Reject |
| D6 | Environmental | 7 (3.41) | 23 (11.22) | 54 (26.34) | 90 (43.9) | 31 (15.12) | 3.6 | 1.0 | 8.1 (.000) | Reject |
| D7 | Organisational | 10 (4.88) | 23 (11.22) | 37 (18.05) | 90 (43.90) | 45 (21.95) | 3.7 | 1.1 | 8.8 (.000) | Reject |
| D8 | Organisational | 10 (4.88) | 27 (13.17) | 75 (36.59) | 61 (29.76) | 32 (15.61) | 3.4 | 1.05 | 5.2 (.000) | Reject |
| D9 | Organisational | 5 (2.44) | 23 (11.22) | 58 (28.29) | 88 (42.93) | 31 (15.12) | 3.6 | 1.0 | 8.5 (.000) | Reject |
| D10 | Technological | 10 (4.88) | 31 (15.12) | 62 (30.24) | 73 (35.61) | 29 (14.15) | 3.4 | 1.1 | 5.3 (.000) | Reject |
| D11 | Technological | 12 (5.85) | 36 (17.56) | 82 (40.00) | 56 (27.32) | 19 (9.27) | 3.2 | 1.0 | 2.3 (.010) | Reject |
| D12 | Technological | 4 (1.95) | 16 (7.80) | 58 (28.29) | 87 (42.44) | 40 (19.51) | 3.7 | .9 | 10.7 (.000) | Reject |
| D13 | Technological | 5 (2.44) | 13 (6.34) | 38 (18.54) | 86 (41.95) | 63 (30.73) | 3.9 | 1.0 | 13.4 (.000) | Reject |
| D14 | Organisational | 5 (2.44) | 13 (6.34) | 43 (20.98) | 94 (45.85) | 50 (24.39) | 3.8 | .95 | 12.6 (.000) | Reject |
| D15 | Environmental | 4 (1.95) | 12 (5.85) | 92 (44.88) | 72 (35.12) | 25 (12.20) | 3.5 | .9 | 8.3 (.000) | Reject |
| D16 | Environmental | 14 (6.83) | 26 (12.68) | 38 (18.54) | 62 (30.24) | 65 (31.71) | 3.7 | 1.2 | 7.8 (.000) | Reject |
| D17 | Environmental | 6 (2.93) | 23 (11.22) | 42 (20.49) | 76 (37.07) | 58 (28.29) | 3.8 | 1.1 | 10.2 (.000) | Reject |

**Source:** Author's Compilation (2025)

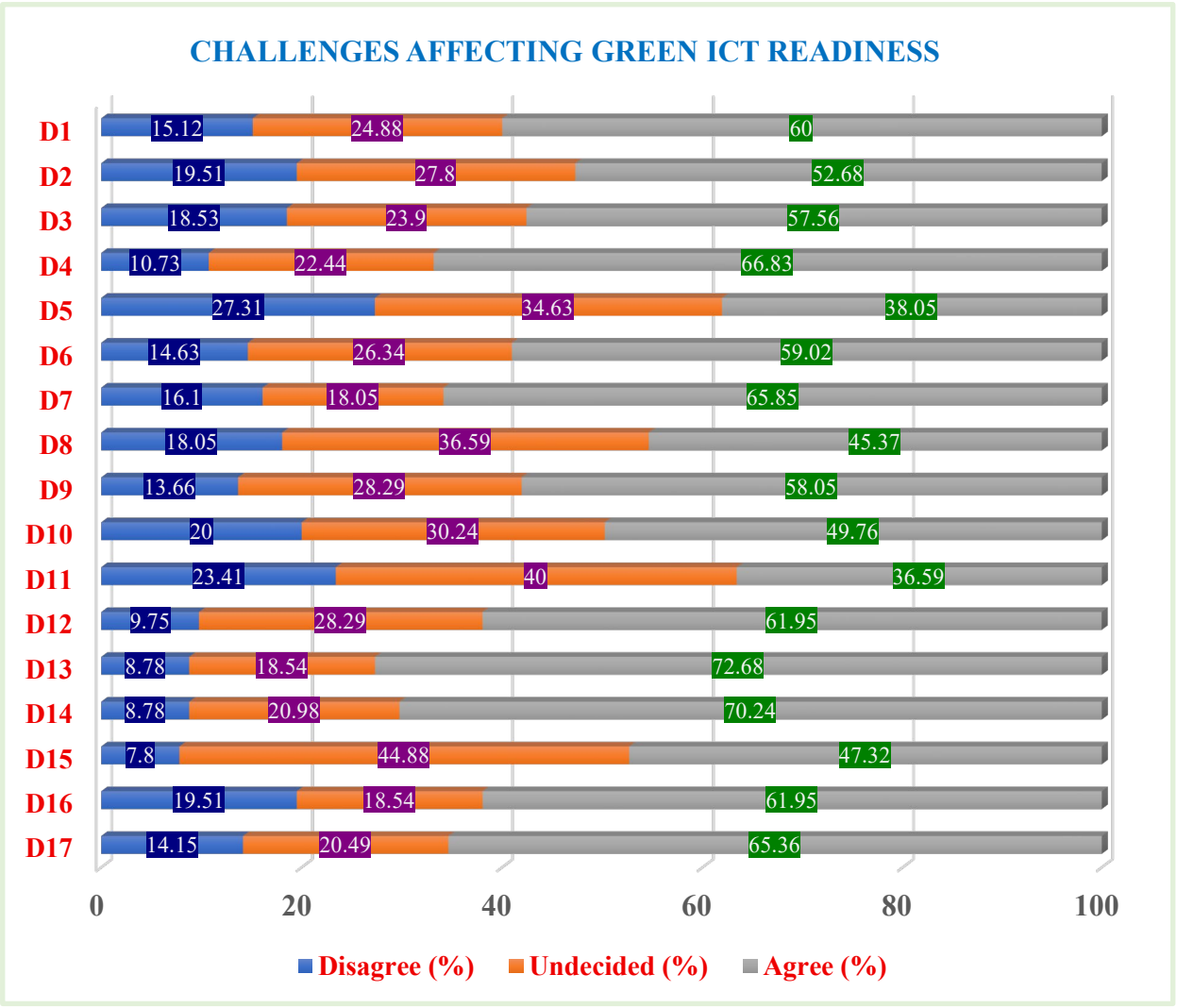


**Figure 5.10:** Green ICT readiness challenges in Organisation A

**Source**: Author's Compilation (2025)

### *5.7.1.1 Secondary objective 2: TOE Category 1 – TECHNOLOGY*

This section analyses the technological factors influencing Organisation A's readiness for Green ICT adoption. These factors are aligned with Construct 2: Green IT Readiness, as defined in the GITAM framework (§3.9.3). The selected variables from Section D of the questionnaire reflect a combination of technological readiness challenges and infrastructure-related barriers that may affect the organisation's ability to implement Green ICT initiatives. The analysis focuses on the following five variables; all grouped under the technological category of the TOE framework:

- *D3 – Technical and Infrastructure Barriers ; D10 – ICT Infrastructure Limitations; D11 – Infrastructure Sufficiency; D12 – Investment in New Technology and D13 – Cost of Infrastructure Upgrades.*

Table 5.16 presents the descriptive statistics, one-sample t-test results for category 1 (Technological Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor influences Organisation A's readiness for transitioning to Green ICT.

**Table 5.16: Results for technological factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| D3 | The technical and infrastructure barriers hinder the adoption of Green ICT in the organisation. | 8 (3.90) | 30 (14.63) | 49 (23.90) | 89 (43.41) | 29 (14.15) | 3.5 | 1.0 | 6.8 (.000) | Reject |
| D10 | The technical limitations of the existing ICT infrastructure prevent Green ICT adoption. | 10 (4.88) | 31 (15.12) | 62 (30.24) | 73 (35.61) | 29 (14.15) | 3.4 | 1.1 | 5.3 (.000) | Reject |
| D11 | My department has sufficient infrastructure to support Green ICT initiatives. | 12 (5.85) | 36 (17.56) | 82 (40.00) | 56 (27.32) | 19 (9.27) | 3.2 | 1.0 | 2.3 (.010) | Reject |
| D12 | The need for new technology investments is a significant barrier to Green ICT adoption. | 4 (1.95) | 16 (7.80) | 58 (28.29) | 87 (42.44) | 40 (19.51) | 3.7 | .9 | 10.7 (.000) | Reject |
| D13 | The cost of upgrading infrastructure to support Green ICT is a significant barrier. | 5 (2.44) | 13 (6.34) | 38 (18.54) | 86 (41.95) | 63 (30.73) | 3.9 | 1.0 | 13.4 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable D3*:** This variable reflects whether the technical and infrastructure barriers hinder the adoption of Green ICT in the organisation. The results show that the majority (57.56%, n=118) of respondents agreed that such barriers hinder adoption. A smaller percentage (18.53%, n=38) disagreed, whilst the remainder (23.90%, n=49) were undecided.

***Variable D10*:** This variable reflects whether the technical limitations of the existing ICT infrastructure prevent Green ICT adoption. The results show that the majority (49.76%, n=102) of respondents agreed that existing ICT limitations pose a barrier. A smaller portion (20.00%, n=41) disagreed, whilst the remainder (30.24%, n=62) were undecided.

***Variable D11*:** This variable reflects whether departments have sufficient infrastructure to support Green ICT initiatives. The results show that a large number (36.59%, n=75) of respondents agreed that their departments have sufficient infrastructure. A smaller percentage (23.41%, n=48) disagreed, whilst the remainder (40.00%, n=82) were undecided.

***Variable D12*:** This variable reflects whether the need for modern technology investments is a significant barrier to Green ICT adoption. The results show that (61.95%, n=127) of respondents agreed that modern technology investments are a barrier. A smaller portion (9.75%, n=20) disagreed, whilst the remainder (28.29%, n=58) were undecided.

***Variable D13*:** This variable reflects whether the cost of upgrading infrastructure to support Green ICT is a significant barrier. The results show that the majority (72.68%, n=149) of respondents agreed that cost is a significant barrier. A smaller percentage (8.78%, n=18) disagreed, whilst the remainder (18.54%, n=38) were undecided.

All variables under the technological category recorded mean values above the neutral benchmark of 3. The results for all five variables (D3, D10, D11, D12 and D13) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the technological category as assessed in Section D of the questionnaire. The following section focuses on the organisational factors influencing Organisation A's readiness for Green ICT adoption, as assessed in Section D of the questionnaire.

#### *5.7.1.2 Secondary objective 2: TOE Category 2 – ORGANISATION*

This section analyses the organisational factors influencing Organisation A's readiness for Green ICT adoption. These factors are aligned with Construct 2: Green IT Readiness, as defined in the GITAM framework (§3.9.3) (Hejri et al., 2022). The selected variables from Section D of the questionnaire reflect a combination of organisational readiness challenges and internal organisational barriers, all categorised under Construct 2: Green IT Readiness.

The analysis focuses on the following seven variables; all grouped under the organisational category of the TOE framework:

- *D1 – Readiness Challenges; D2 – Strategic and Organisational Barriers; D4 – Financial Barriers; D7 – Strategic Alignment; D8 – Leadership Support; D9 – Departmental Coordination and D14 – Financial Resource Limitations.*

Table 5.17 presents the descriptive statistics, one-sample t-test results for category 2 (Organisational Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Organisation A's readiness for Green ICT adoption.

**Table 5.17: Results for the organisational factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| D1 | The readiness challenges hinder the adoption of Green ICT in the organisation. | 7 (3.41) | 24 (11.71) | 51 (24.88) | 100 (48.78) | 23 (11.22) | 3.5 | 1.0 | 7.9 (.000) | Reject |
| D2 | The organisational and strategic barriers hinder the adoption of Green ICT in the organisation. | 7 (3.41) | 33 (16.10) | 57 (27.80) | 78 (38.05) | 30 (14.63) | 3.4 | 1.0 | 6.1 (.000) | Reject |
| D4 | The financial barriers hinder the adoption of Green ICT in the organisation. | 4 (1.95) | 18 (8.78) | 46 (22.44) | 78 (38.05) | 59 (28.78) | 3.8 | 1.0 | 11.8 (.000) | Reject |
| D7 | The lack of strategic alignment across departments affects the adoption of Green ICT. | 10 (4.88) | 23 (11.22) | 37 (18.05) | 90 (43.90) | 45 (21.95) | 3.7 | 1.1 | 8.8 (.000) | Reject |
| D8 | The organisational leadership has prioritised Green ICT in the company's overall strategy. | 10 (4.88) | 27 (13.17) | 75 (36.59) | 61 (29.76) | 32 (15.61) | 3.4 | 1.05 | 5.2 (.000) | Reject |
| D9 | The lack of coordination between departments hinders the implementation of Green ICT policies. | 5 (2.44) | 23 (11.22) | 58 (28.29) | 88 (42.93) | 31 (15.12) | 3.6 | 1.0 | 8.5 (.000) | Reject |
| D14 | The limited financial resources hinder the adoption of Green ICT practices within the organisation. | 5 (2.44) | 13 (6.34) | 43 (20.98) | 94 (45.85) | 50 (24.39) | 3.8 | .95 | 12.6 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable D1***: This variable reflects whether readiness challenges hinder the adoption of Green ICT in the organisation. The results show that the majority (59.99%, n=123) of respondents agreed that readiness challenges are a barrier. A smaller portion (15.12%, n=31) disagreed, whilst the remainder (24.88%, n=51) were undecided.

***Variable D2***: This variable reflects whether organisational and strategic barriers hinder Green ICT adoption in the organisation. The results show that the majority (52.68%, n=108) of respondents agreed that such barriers exist. A smaller proportion (19.51%, n=40) disagreed, whilst the remainder (27.80%, n=57) were undecided.

***Variable D4***: This variable reflects whether financial barriers hinder the adoption of Green ICT in the organisation. The results show that the majority (66.83%, n=137) of respondents agreed that financial constraints are a significant barrier. A small portion (10.73%, n=22) disagreed, whilst the remainder (22.44%, n=46) were undecided.

***Variable D7***: This variable reflects whether a lack of strategic alignment across departments affects the adoption of Green ICT. The results show that the majority (65.85%, n=135) of respondents agreed that misalignment is an issue. A smaller percentage (16.10%, n=33) disagreed, whilst the remainder (18.05%, n=37) were undecided.

***Variable D8***: This variable reflects whether organisational leadership has prioritised Green ICT in the company's overall strategy. The results show that the majority (45.37%, n=93) of respondents agreed that Green ICT is prioritised by leadership. A similar portion (31.71%, n=65) were undecided, while the remainder (18.05%, n=37) disagreed.

***Variable D9***: This variable reflects whether the lack of coordination between departments hinders the implementation of Green ICT policies. The results show that the majority (58.05%, n=119) of respondents agreed that coordination is a barrier. A smaller percentage (13.66%, n=28) disagreed, whilst the remainder (28.29%, n=58) were undecided.

***Variable D14***: This variable reflects whether limited financial resources hinder the adoption of Green ICT practices within the organisation. The results show that the majority (70.24%, n=144) of respondents agreed that limited funding is a constraint. A small portion (8.78%, n=18) disagreed, whilst the remainder (20.98%, n=43) were undecided.

All variables under the organisational category recorded mean values above the neutral benchmark of 3. The results for all seven variables (D1, D2, D4, D7, D8, D9 and D14) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.95 to 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the organisational category as assessed in Section D of the questionnaire. The

following section focuses on the environmental factors influencing Organisation A's readiness for Green ICT adoption, as assessed in Section D of the questionnaire.

#### *5.7.1.3 Secondary objective 2: TOE Category 3 – ENVIRONMENT*

This section analyses the environmental factors influencing Organisation A's readiness for Green ICT adoption. These factors are aligned with Construct 2: Green IT Readiness, as defined in the GITAM framework (§3.9.3) (Hejri et al., 2022). The selected variables from Section D of the questionnaire reflect a combination of organisational readiness challenges and internal organisational barriers, all categorised under Construct 2: Green IT Readiness. The analysis focuses on the following five variables; all grouped under the environmental category of the TOE framework:

- *D5 – Policy and Regulatory Barriers; D6 – External and Physical Barriers; D15 – Compliance with International Standards; D16 – External Operational Factors and D17 – Geographical Challenges.*

Table 5.18 presents the descriptive statistics, one-sample t-test results for category 3 (Environmental Factors) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Organisation A's readiness for Green ICT adoption.

**Table 5.18: Results for the environmental factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| D5 | The policy and regulatory barriers hinder the adoption of Green ICT in the organisation. | 8 (3.90) | 48 (23.41) | 71 (34.63) | 56 (27.32) | 22 (10.73) | 3.2 | 1.0 | 2.4 (.008) | Reject |
| D6 | The external and physical barriers hinder the adoption of Green ICT in the organisation. | 7 (3.41) | 23 (11.22) | 54 (26.34) | 90 (43.9) | 31 (15.12) | 3.6 | 1.0 | 8.1 (.000) | Reject |
| D15 | The organisation is compliant with international Green ICT standards and regulations. | 4 (1.95) | 12 (5.85) | 92 (44.88) | 72 (35.12) | 25 (12.20) | 3.5 | .9 | 8.3 (.000) | Reject |

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| D16 | The external factors (e.g. power outages and loadshedding) hinder Green ICT adoption. | 14 (6.83) | 26 (12.68) | 38 (18.54) | 62 (30.24) | 65 (31.71) | 3.7 | 1.2 | 7.8 (.000) | Reject |
| D17 | The geographical challenges (e.g. remote infrastructure) affect the adoption of Green ICT. | 6 (2.93) | 23 (11.22) | 42 (20.49) | 76 (37.07) | 58 (28.29) | 3.8 | 1.1 | 10.2 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable D5*:** This variable reflects whether policy and regulatory barriers hinder the adoption of Green ICT in the organisation. The results show that the majority (38.05%, n = 78) of respondents disagreed with the statement. A smaller portion (27.32%, n = 56) agreed, whilst the remainder (34.63%, n = 71) were undecided.

***Variable D6*:** This variable reflects whether external and physical barriers hinder the adoption of Green ICT in the organisation. The results show that the majority (59.02%, n = 121) of respondents agreed that these barriers hinder adoption. A smaller portion (14.63%, n = 30) disagreed, whilst the remainder (26.34%, n = 54) were undecided.

***Variable D15*:** This variable reflects whether the organisation is compliant with international Green ICT standards and regulations. The results show that the majority (47.32%, n = 97) of respondents agreed with the statement. A small portion (7.80%, n = 16) disagreed, whilst the remainder (44.88%, n = 92) were undecided.

***Variable D16*:** This variable reflects whether external factors (e.g. power outages and loadshedding) hinder Green ICT adoption. The results show that the majority (61.95%, n = 127) of respondents agreed with the statement. A smaller portion (19.51%, n = 40) disagreed, whilst the remainder (18.54%, n = 38) were undecided.

***Variable D17*:** This variable reflects whether geographical challenges (e.g. remote infrastructure) affect the adoption of Green ICT in the organisation. The results show that the majority (65.36%, n = 134) of respondents agreed with the statement. A smaller portion (14.15%, n = 29) disagreed, whilst the remainder (20.49%, n = 42) were undecided.

All variables under the environmental category recorded mean values above the neutral benchmark of 3. The results for all five variables (D5, D6, D15, D16 and D17) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.2, indicating

moderate variability in responses. These results reflect the descriptive statistical outputs for the environmental category as assessed in Section D of the questionnaire.

### 5.7.2 Summary of Section D: Green ICT Readiness – Challenges and Barriers

Section D analysed the contextual factors influencing Green ICT readiness in Organisation A, directly addressing the secondary objective 2 of the study—to investigate the challenges and barriers that impact Organisation A's transition to Green ICT. The analysis was based on Construct 2 of the GITAM framework (§3.9.3) (Hejri et al., 2022), with variables grouped under the TOE framework dimensions: technological (D3, D10 to D13), organisational (D1, D2, D4, D7 to D9, D14), and environmental (D5, D6, D15 to D17), as outlined in Chapter 3.

The data were collected through Section D of the questionnaire and analysed using one-sample t-tests, as explained in Chapter 4 (§4.10.2). All variables recorded mean scores at or above the neutral benchmark of 3 and were statistically significant at the 5% or 1% level ($p < 0.05$), indicating general agreement with the stated challenges and barriers. Among the organisational variables, D1 and D4 received particularly strong support, with mean scores of 3.5 and 3.8, respectively. The highest overall score was recorded for D13 (mean = 3.9, $p < 0.001$), highlighting the cost of upgrading infrastructure as a significant barrier. The lowest was for D5 (mean = 3.2, $p = 0.008$), which still indicated agreement but with slightly less intensity.

These findings provide statistical evidence that the readiness of Organisation A to implement Green ICT is affected by a combination of technological, organisational and environmental challenges. The consistent rejection of the null hypothesis supports hypothesis H2, which proposes that such challenges significantly influence Green ICT readiness. A detailed interpretation of these findings is provided in the next section, with final conclusions and recommendations presented in Chapter 6.

## 5.8 ANALYSIS AND RESULTS OF SECTION E: GREEN IT DRIVERS (EMPLOYEE PERCEPTION AND PARTICIPATION)

This section presents the statistical analysis of Section E of the questionnaire, which aligns with secondary research objective 3 of the study. This section of the questionnaire consisted of

9 variables. During the analysis phase, these 9 variables were categorised under the organisational and environmental categories of the TOE framework.

### 5.8.1 Secondary research objective 3:

- ***To determine the level of employee awareness, involvement and perceptions regarding the green ICT initiatives in Organisation A.***

The analysis is based on Construct 3: Green IT Drivers, as defined in the GITAM framework and discussed in Chapter 3 (§3.9.4) (Molla, 2008). This construct examines the internal and external motivational factors such as organisational identity, stakeholder engagement, strategic priorities and regulatory influences that drive the adoption of Green ICT. The TOE framework provides a structured analytical lens for categorising and interpreting these drivers across the organisational and environmental dimensions. To evaluate this objective, both descriptive statistics (mean and standard deviation) and inferential statistics (one-sample t-tests) were applied, as outlined in Chapter 4 (§4.10) (Babbie, 2016). The one-sample t-test assessed whether the mean scores for each item significantly deviated from the neutral reference point of 3 on a five-point Likert scale. This approach provides a statistical indication of how employees perceive and engage with Green ICT initiatives within Organisation A.

Table 5.19 presents the descriptive and inferential statistics for each variable in Section E, including Likert scale response distributions, mean scores, standard deviations and one-sample t-test results. This table provides a comprehensive overview of employee perceptions, awareness and participation levels as key drivers influencing the implementation of Green ICT in the organisation.

**Table 5.19: Descriptive and inferential statistical results: Drivers influencing Green ICT adoption within Organisation A**

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| E1 | Organisation | 13 (6.34) | 37 (18.05) | 47 (22.93) | 81 (39.51) | 27 (13.17) | 3.35 | 1.1 | 4.5 (.000) | Reject |
| E2 | Organisation | 23 (11.22) | 67 (32.68) | 61 (29.76) | 39 (19.02) | 15 (7.32) | 2.8 | 1.1 | -2.8 (.003) | Reject |

| No. | TOE Category | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| E3 | Environment | 7 (3.41) | 17 (8.29) | 77 (37.56) | 67 (32.68) | 37 (18.05) | 3.5 | 1.0 | 7.7 (.000) | Reject |
| E4 | Organisation | 18 (8.78) | 58 (28.29) | 65 (31.71) | 48 (23.41) | 16 (7.80) | 2.9 | 1.1 | -0.9 (.185) | **Accept** |
| E5 | Organisation | 5 (2.44) | 22 (10.73) | 80 (39.02) | 74 (36.10) | 24 (11.71) | 3.4 | .9 | 6.8 (.000) | Reject |
| E6 | Organisation | 5 (2.44) | 18 (8.78) | 79 (38.54) | 74 (36.10) | 29 (14.15) | 3.5 | .9 | 7.8 (.000) | Reject |
| E7 | Organisation | 12 (5.85) | 42 (20.49) | 81 (39.51) | 55 (26.83) | 15 (7.32) | 3.1 | 1.0 | 1.3 (.093) | **Accept** |
| E8 | Organisation | 6 (2.93) | 14 (6.83) | 73 (35.61) | 78 (38.05) | 34 (16.59) | 3.6 | .9 | 8.9 (.000) | Reject |
| E9 | Environment | 4 (1.95) | 28 (13.66) | 96 (46.83) | 57 (27.80) | 20 (9.76) | 3.1 | .9 | 4.8 (.000) | Reject |

**Source:** Author's Compilation (2025)

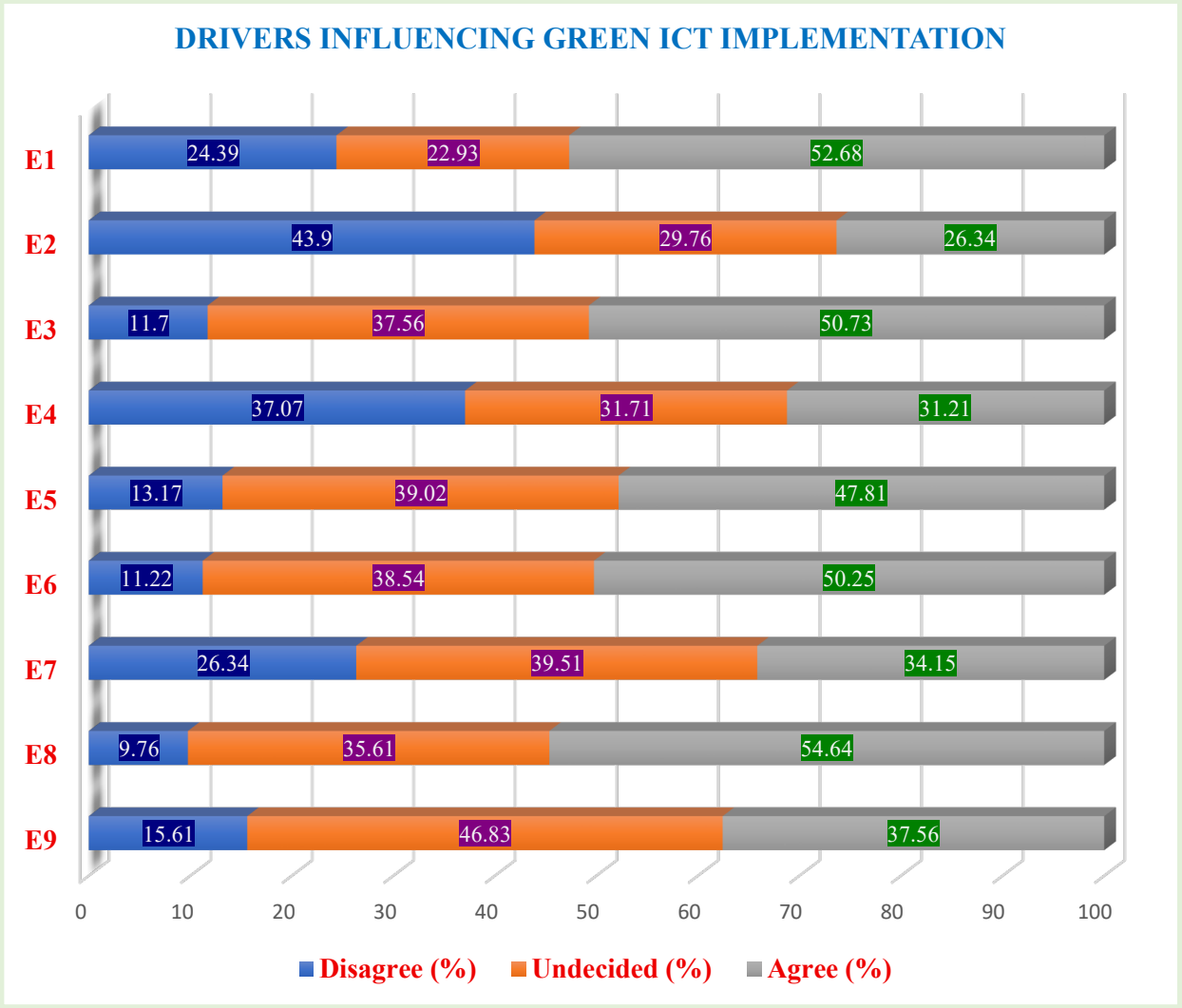


**Figure 5.11:** Drivers influencing the implementation of Green ICT in Organisation A

**Source:** Author's Compilation (2025)

#### *5.8.1.1 Secondary objective 3: TOE Category 2 – ORGANISATION*

This section presents the analysis of organisational drivers influencing the successful implementation of Green ICT initiatives within Organisation A. These drivers are aligned with Construct 3: Drivers of Green IT, as defined in the GITAM framework (§3.9.4) (Molla, 2008). The variables selected from Section E of the questionnaire reflect key internal motivators, including organisational commitment, communication, involvement, alignment with strategic goals and departmental engagement. The analysis focuses on the following seven variables, each classified under the organisational category of the TOE framework:

- *E1 – Awareness of Green ICT Initiatives; E2 – Employee Involvement; E4 – Communication Effectiveness; E5 – Organisational Culture; E6 – Strategic Alignment; E7 – Departmental Engagement and E8 – Organisational Commitment.*

Table 5.20 presents the descriptive statistics, one-sample t-test results and Likert scale distribution for these organisational drivers. The results are followed by a detailed interpretation of each variable to assess how they contribute to driving Green ICT adoption within Organisation A.

**Table 5.20: Results for the organisational factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | | | |
| E1 | I am aware of the Green ICT initiatives implemented within the organisation. | 13 (6.34) | 37 (18.05) | 47 (22.93) | 81 (39.51) | 27 (13.17) | 3.35 | 1.1 | 4.5 (.000) | Reject |
| E2 | I feel involved in the Green ICT initiatives in the organisation. | 23 (11.22) | 67 (32.68) | 61 (29.76) | 39 (19.02) | 15 (7.32) | 2.8 | 1.1 | -2.8 (.003) | Reject |
| E4 | The communication regarding Green ICT initiatives within the organisation is effective. | 18 (8.78) | 58 (28.29) | 65 (31.71) | 48 (23.41) | 16 (7.80) | 2.9 | 1.1 | -0.9 (.185) | **Accept** |

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| E5 | Organisation A's culture supports Green ICT initiatives. | 5 (2.44) | 22 (10.73) | 80 (39.02) | 74 (36.10) | 24 (11.71) | 3.4 | .9 | 6.8 (.000) | Reject |
| E6 | Green ICT initiatives align well with Organisation A's overall strategic goals. | 5 (2.44) | 18 (8.78) | 79 (38.54) | 74 (36.10) | 29 (14.15) | 3.5 | .9 | 7.8 (.000) | Reject |
| E7 | My department is engaged with Green ICT initiatives. | 12 (5.85) | 42 (20.49) | 81 (39.51) | 55 (26.83) | 15 (7.32) | 3.1 | 1.0 | 1.3 (.093) | **Accept** |
| E8 | Organisation A is committed to Green ICT initiatives. | 6 (2.93) | 14 (6.83) | 73 (35.61) | 78 (38.05) | 34 (16.59) | 3.6 | .9 | 8.9 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable E1*:** This variable reflects whether respondents are aware of the Green ICT initiatives implemented within the organisation. The results indicate that the majority (52.68%, n=108) of respondents agreed that they are aware of these initiatives. A smaller proportion (24.39%, n=50) disagreed, whilst the remainder (22.93%, n=47) were undecided.

***Variable E2*:** This variable reflects whether respondents feel involved in the Green ICT initiatives within the organisation. The results show that only a small number (26.34%, n=54) of respondents agreed that they are involved. A larger percentage (43.90%, n=90) disagreed, whilst the remainder (29.76%, n=61) were undecided.

***Variable E4*:** This variable reflects whether the communication regarding Green ICT initiatives within the organisation are effective. The results reveal that an average number (31.21%, n=64) of respondents agreed that communication is effective. However, a similar number (37.07%, n=76) disagreed, whilst the remainder (31.71%, n=65) were undecided.

***Variable E5*:** This variable reflects whether Organisation A's culture supports Green ICT initiatives. The results indicate that the majority (47.81%, n=98) of respondents agreed that the organisational culture is supportive. A much smaller proportion (13.17%, n=27) disagreed, whilst the remainder (39.02%, n=80) were undecided.

***Variable E6*:** This variable reflects whether Green ICT initiatives align well with Organisation A's overall strategic goals. The results show that the majority (50.25%, n=103) of respondents agreed that the initiatives are aligned. A smaller group (11.22%, n=23) disagreed, whilst the remainder (38.54%, n=79) were undecided.

***Variable E7*:** This variable reflects whether respondents feel their department is engaged with Green ICT initiatives. The results reveal that only an average number (34.15%, n=70) of respondents agreed that their department is engaged. A slightly higher percentage (26.34%, n=54) disagreed, whilst the remainder (39.51%, n=81) were undecided.

***Variable E8*:** This variable reflects whether Organisation A is committed to Green ICT initiatives. The results show that the majority (54.64%, n=112) of respondents agreed that the organisation is committed. A small proportion (9.76%,n=20) disagreed, whilst the remainder (35.61%, n=73) were undecided.

All variables under the organisational category recorded mean values above the neutral benchmark of 3. The results for five out of the seven organisational variables (E1, E3, E5, E6, and E8) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.1, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the organisational category as assessed in Section E of the questionnaire. The following section focuses on the environmental drivers influencing Organisation A's motivation to adopt Green ICT, as assessed in Section E of the questionnaire.

#### *5.8.1.2 Secondary objective 3: TOE Category 3 – ENVIRONMENT*

This section analyses the environmental factors that drive Organisation A's adoption of Green ICT initiatives. These factors are aligned with Construct 3: Drivers of Green IT, as defined in the GITAM framework (§3.9.4). The selected variables from Section E of the questionnaire reflect external motivational factors categorised under Construct 3: Drivers of Green IT. The analysis focuses on the following two variables under the environmental category of the TOE framework:

- *E3 – Sustainability and Environmental Impact; and E9 – Stakeholder Engagement*

Table 5.21 presents the descriptive statistics, one-sample t-test results for the environmental drivers (E3 and E9) and Likert scale distributions. This is followed by a detailed interpretation of the data to assess how each factor contributes to Organisation A's motivation for Green ICT adoption.

**Table 5.21: Results for the environmental factors**

| No. | Variable | *Strongly Disagree* | *Disagree* | *Undecided* | *Agree* | *Strongly Agree* | Mean | Std. Dev | t (p) | Reject/ Accept |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | | | | |
| E3 | The Green ICT initiatives are effective in improving Organisation A's sustainability. | 7 (3.41) | 17 (8.29) | 77 (37.56) | 67 (32.68) | 37 (18.05) | 3.5 | 1.0 | 7.7 (.000) | Reject |
| E9 | Stakeholders are adequately engaged in supporting Green ICT initiatives in the organisation. | 4 (1.95) | 28 (13.66) | 96 (46.83) | 57 (27.80) | 20 (9.76) | 3.1 | .9 | 4.8 (.000) | Reject |

**Source:** Author's Compilation (2025)

***Variable E3***: This variable reflects whether respondents believe the Green ICT initiatives are effective in improving Organisation A's sustainability. The results show that the majority (50.73%, n=104) of respondents agreed with this statement. A smaller percentage (11.70%, n=24) disagreed, whilst the remainder (37.56%, n=77) were undecided.

***Variable E9***: This variable reflects whether stakeholders are adequately engaged in supporting Green ICT initiatives in the organisation. The results show that an average number (37.56%, n=77) of respondents agreed that stakeholder engagement is adequate. A smaller proportion (15.61%, n=32) disagreed, whilst the remainder (46.83%, n=96) were undecided.

All variables under the environmental category recorded mean values at or above the neutral benchmark of 3. Both variables (E3 and E9) were statistically significant at the 5% level ($p < 0.05$). Standard deviations ranged from 0.9 to 1.0, indicating moderate variability in responses. These results reflect the descriptive statistical outputs for the environmental category as assessed in section E of the questionnaire.

### 5.8.2 Summary of Section E: Employee Awareness, Involvement and Perceptions of Green ICT Initiatives

Section E analysed the contextual factors influencing Green ICT drivers in Organisation A, directly addressing secondary objective 3—to determine the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A. The analysis was based on Construct 3 of the GITAM framework (§3.9.4) (Cordero et al., 2023),

with variables grouped under the TOE dimensions: organisational (E1, E2, E4–E8) and environmental (E3 and E9), as detailed in Chapter 3. These were operationalised through Section E questionnaire items and statistically analysed using one-sample t-tests (§4.10.2).

Most variables produced mean scores above the neutral benchmark of 3 and were statistically significant at either the 5% or 1% level, reflecting overall agreement with the associated statements. One item (E4) yielded a borderline result (mean = 2.9, p = 0.185), while another (E7) returned a neutral score (mean = 3.1, p = 0.093).

These analysis and results provide statistical evidence of the importance of internal drivers, particularly organisational and environmental perceptions, in supporting Green ICT initiatives. The consistent rejection of the null hypothesis across most variables supports hypothesis H3, which posits that employee awareness, involvement and perceptions significantly influence the success of Green ICT implementation. A detailed evaluation of this hypothesis follows in the next section, with consolidated conclusions and practical recommendations presented in Chapter 6.

## 5.9 ANALYSIS OF SECTION F: OPEN-ENDED RESPONSES ON GREEN ICT STRATEGIES

Section F analysed the open-ended responses provided by respondents regarding potential strategies that Organisation A could adopt to enhance its transition to Green ICT. This section addressed secondary objective 4, to provide recommendations on strategies for Organisation A to overcome challenges and barriers in their green ICT implementation process.

Although no statistical tests were applied, the responses were systematically reviewed and summarised to capture the collective insights of employees. Respondents highlighted the need for stronger leadership direction, greater awareness of initiatives and improved opportunities for engagement; supported by effective communication practices. They emphasised the importance of training and education, investment in modern infrastructure and adequate budgeting and resource allocation to ensure sustainability. Suggestions also pointed to the value of innovation and research in driving new approaches; as well as alignment with organisational strategy, policy and compliance requirements. Collaboration and partnerships, both internally and externally, were viewed as essential to enhancing Green ICT initiatives, while operational

challenges such as loadshedding and geographic constraints were recognised as barriers that require proactive management. In addition, respondents noted the role of employee involvement and wider community engagement in strengthening commitment to Green ICT objectives. Collectively, these insights provide practical and context-specific guidance to complement the quantitative findings presented in earlier sections and will inform the final recommendations in Chapter 6. The following section presents the correlation and regression analyses conducted to assess the statistical relationships among the study variables and to test hypotheses H1, H2 and H3.

## 5.10 CORRELATION, REGRESSION ANALYSIS AND HYPOTHESIS TESTING

This section presents the results of the correlation and regression analyses used to evaluate the relationships between the study variables and to test hypotheses H1, H2 and H3. The Pearson correlation coefficient and multiple linear regression techniques were used in line with the statistical methodology outlined in Chapter 4 (§4.10.2).

### 5.10.1 Correlation analysis

As established in Chapter 4 (§4.10.2), this study employed the Pearson correlation coefficient to examine the linear relationships between the key variables under investigation. The rationale and theoretical basis for this approach were outlined in Chapter 2 (§2.4.2), which identified a comprehensive range of internal and external drivers influencing Green ICT implementation. These include financial motivations (§2.4.2.1) (Lutkevich & McLaughlin, 2023); strategic and operational excellence (§2.4.2.2); regulation, risk and compliance (§2.4.2.3) (Theis & Schreiber, 2020); organisational identity, culture and talent (§2.4.2.4); stakeholder engagement and partnership (§2.4.2.5) and sustainability, global dynamics and social responsibility (§2.4.2.6). The correlation analysis presented in this section explores the associations between these variables to determine the extent of their statistical relationships. This empirical analysis aligns with the conceptual framework discussed in the literature review, which highlighted how challenges in transitioning to Green ICT (§2.4.3) are often intertwined with organisational readiness, stakeholder expectations and employee engagement. By quantifying these relationships, this section provides foundational insights into how these drivers and barriers interact within the context of Organisation A.

The Pearson correlation coefficient indicates the strength of a linear relationship between two variables, but its value generally does not completely characterise their relationship. In this study, the Pearson correlation coefficient was used to investigate the correlations between the key study variables as follows.

The variables are:

- **Y** = The "effectiveness and adoption of Green ICT practices";
- **X1** = The "primary challenges facing a SA telecommunication organisation in transitioning to Green ICT";
- **X2** = The "challenges and barriers that impact Organisation A's transition to Green ICT" and
- **X3 =** The "employee awareness, involvement and perceptions regarding the Green ICT initiatives in the organisation".

Table 5.22 presents the Pearson correlation coefficients among the study's key variables. This matrix illustrates the strength and direction of linear relationships between the primary challenges (X1), challenges and barriers (X2), employee awareness and perceptions (X3), and the effectiveness and adoption of Green ICT practices (Y).

**Table 5.22: Pearson correlation matrix of key constructs related: Green ICT adoption within Organisation A**

| Variable | X1 | Y | X2 | X3 |
|---|---|---|---|---|
| **X1** | 1 | | | |
| **Y** | 0.380* | 1 | | |
| **X2** | 0.507* | -0.013 | 1 | |
| **X3** | 0.273* | 0.744** | 0.128 | 1 |

Note: * This indicates that the variables are correlated at the 5% level of significance.

** This indicates that the variables are correlated at the 1% level of significance.

**Source:** Author's Compilation (2025)

Figure 5.12 below presents a heat map visualisation of the Pearson correlation matrix outlined in Table 5.22. This graphical representation enhances interpretation by displaying the strength and direction of relationships between the key study variables through a colour gradient. Darker shades represent stronger correlations—positive correlations are shaded in green, while

negative correlations, if present, are shaded in red. This visual aid supports a clearer understanding of the interplay between challenges, employee involvement and the effectiveness of Green ICT adoption within Organisation A.

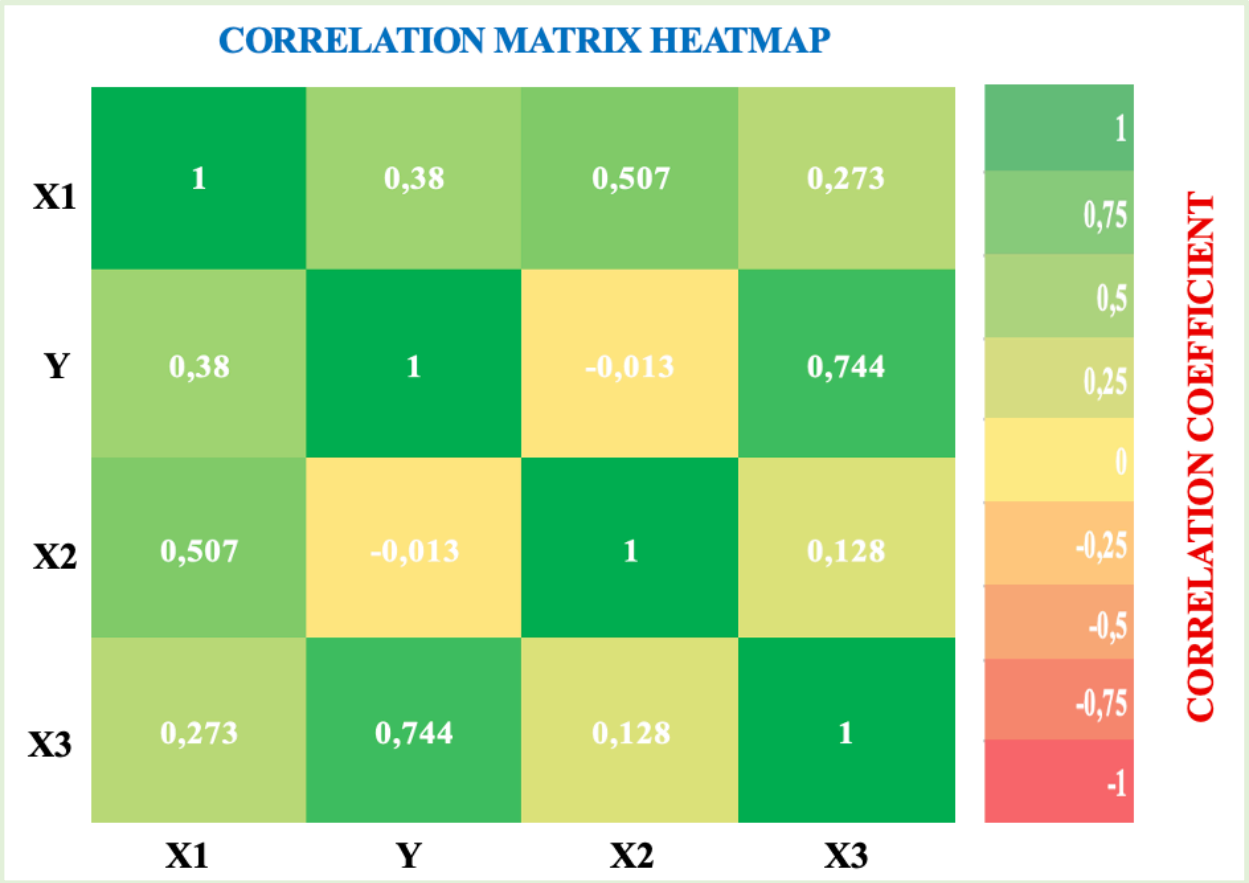


**Figure 5.12:** Heat map visualisation of Pearson correlation coefficients

**Source:** Author's Compilation (2025)

The results presented in Table 5.22 and visualised in Figure 5.12 indicate that X1 (the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT) is positively correlated with Y (the effectiveness and adoption of Green ICT practices) at a moderate level (r = 0.380). X1 is also strongly positively correlated with X2 (the challenges and barriers that impact Organisation A's transition to Green ICT) (r = 0.507), as theoretically expected. Furthermore, a weaker but still statistically significant positive correlation is observed between X1 and X3 (the employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A) (r = 0.273). Notably, Y demonstrates a negligible negative correlation with X2 (r = -0.013), indicating minimal linear association. However, Y is strongly positively correlated with X3 (r = 0.744), indicating a substantial relationship

between effective Green ICT adoption and employee engagement. These relationships are further reinforced by the heat map in Figure 5.12, where stronger correlations appear in darker shades of green, providing a clear visual interpretation of the underlying statistical associations.

### 5.10.2 The multicollinearity problem

Multicollinearity arises in linear regression models when two or more predictor variables are highly correlated, leading to inflated standard errors, unstable coefficient estimates and difficulties in model interpretation (Ghorbani, 2020). In this study, regression diagnostics identified a potential multicollinearity issue between the independent variables X1 (the primary challenges facing a SA telecommunication organisation in transitioning to Green ICT) and X2 (the challenges and barriers that impact Organisation A's transition to Green ICT). Due to their strong correlation, the inclusion of both variables could distort the statistical significance of model coefficients. To improve the robustness and interpretability of the regression model, X1 was excluded. The final regression therefore retained X2 and X3 (the employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A) as independent variables for predicting Y (the effectiveness and adoption of Green ICT practices).

### 5.10.3 Regression analysis

As outlined in Chapter 4 (§4.10.4), this study employed multiple linear regression to evaluate the combined influence of selected independent variables on the dependent variable. This approach is grounded in the conceptual framework discussed in Chapter 3 (§3.9) (Alkali et al., 2017), which integrates the theoretical drivers and barriers influencing Green ICT adoption, drawing on the GITAM and TOE frameworks. Following the multicollinearity diagnostics detailed in Chapter 5 (§5.10.2), the regression model was refined by excluding X1 due to its strong correlation with X2. The multiple linear regression model is expressed as follows:

$Y = \alpha+\beta1X2+\beta2X3+ e$

Where:

- Y is the dependent variable, defined as the effectiveness and adoption of Green ICT practices.
- $\alpha$ is the intercept or constant term.
- $\beta_1$ and $\beta_2$ are the regression coefficients for the predictors.

- $X_2$ refers to the challenges and barriers that impact Organisation A's transition to Green ICT.
- $X_3$ denotes the employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A.
- $e$ is the error term, assumed to be normally distributed with a mean of zero and constant variance.

This model captures the predictive relationship between internal barriers and employee engagement in determining the effectiveness of Green ICT implementation within Organisation A.

### 5.10.4 Hypothesis Testing:

***H1: The current state of Green ICT adoption in Organisation A is suboptimal.***

Hypothesis H1 proposed that the current state of Green ICT adoption in Organisation A is suboptimal. To evaluate this, a one-sample t-test was conducted to determine whether the mean score for the relevant construct was significantly different from the neutral benchmark of 3 on a 5-point Likert scale. A mean significantly higher than 3 would indicate that respondents perceive Green ICT adoption as favourable, thereby leading to the rejection of the hypothesis.

While hypothesis H1 was initially associated with the construct “primary challenges facing a South African telecommunication organisation in transitioning to Green ICT” (X1), multicollinearity concerns (§5.10.2) revealed a strong correlation between X1 and X2. As a result, X2—“challenges and barriers that impact Organisation A’s transition to Green ICT”—was substituted as a proxy for X1 in order to preserve model validity and avoid redundancy in explanatory variables.

X2 is based on Construct 2: Green information technology readiness, introduced in Chapter 3 (§3.9.2), and draws on the TOE framework (Technology-Organisation-Environment) to capture the internal and external challenges shaping an organisation’s preparedness for Green ICT adoption. It was operationalised using 17 questionnaire items and a composite mean score was computed to assess the organisation's readiness status from the employees’ perspective.

Table 5.23 displays the detailed output of the one-sample t-test, including the mean, standard error, degrees of freedom, confidence intervals and significance level.

**Table 5.23: One-sample t-test results for Green ICT adoption (X2)**

| **mean = mean(X2)** | | | **degrees of freedom = 204** | | |
|---|---|---|---|---|---|
| **Variable** | **No. of Obs.** | **Mean** | **Std. Err.** | **t = 6.9 (.000)** | **[95% Conf. Interval]** |
| X2 | 205 | 3.337 | .049 | | 3.240 3.433 |

**Source:** Author's Compilation (2025)

Figure 5.13 presents a bar chart illustrating the mean score along with its 95% confidence interval, providing a visual understanding of the result and the associated error margin.

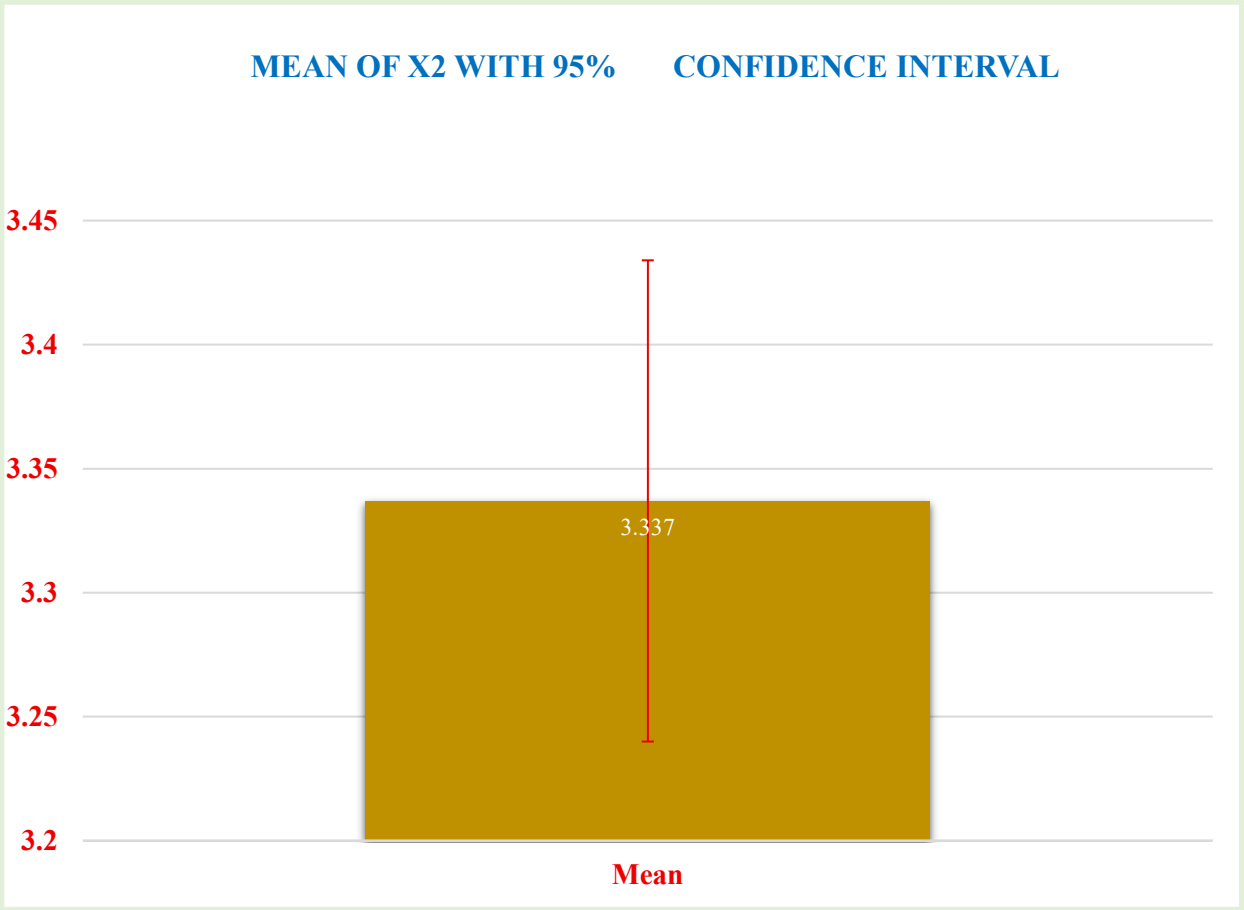


**Figure 5.13:** Mean score of X2 (Challenges and barriers to green ICT adoption) with 95% confidence interval

**Source:** Author's Compilation (2025)

Figure 5.13 visually reinforces the statistical result, showing that the entire confidence interval lies above the reference value of 3. The graph helps clarify the magnitude and precision of the observed mean in relation to the hypothesised benchmark. The composite mean score for X2 was 3.337, with a standard error of 0.049, indicating low variability around the sample mean. The resulting t-value of 6.9 reflects a statistically significant difference from the test value of 3.000. The associated p-value of 0.000 is well below the conventional 0.01 threshold, demonstrating a high level of statistical significance. The 95% confidence interval, ranging from 3.240 to 3.433, indicates that the true population mean is likely to fall within this range. Since the entire interval lies above the neutral midpoint of the scale, the result indicates a meaningful deviation from the test value. These results are visually represented in Figure 5.13, which illustrates both the mean and the margin of error, enhancing the interpretability of the statistical output.

### 5.10.5 Hypothesis Testing:

***H2: There are significant challenges and barriers affecting Organisation A's transition to Green ICT.***

Hypothesis H2 proposed that there are significant challenges and barriers affecting Organisation A's transition to Green ICT. To evaluate this, a multiple linear regression analysis was conducted to determine whether perceived readiness barriers (X2) and employee-related factors (X3) significantly predict the effectiveness and adoption of Green ICT practices (Y). Statistically significant coefficients would support the hypothesis by indicating that these factors meaningfully influence implementation outcomes. Drawing from the conceptual framework and the Green IT Adoption Model (GITAM), hypothesis H2 was formulated to assess the extent to which these perceived challenges and barriers (X2), along with employee awareness, involvement and perceptions (X3), impact the effectiveness of Green ICT implementation within Organisation A.

To test hypothesis H2, a multiple linear regression analysis was conducted. The dependent variable was the "effectiveness and adoption of Green ICT practices" (Y), while the independent variables included:

- **X2** – perceived organisational, technological and environmental challenges and barriers and
- **X3** – employee awareness, involvement and perceptions regarding Green ICT initiatives.

Table 5.24 presents the regression outcomes, displaying the coefficients, standard errors, t-values, p-values and 95% confidence intervals.

**Table 5.24: Multiple regression results for Green ICT adoption (Excluding Social Exclusion)**

| (a) Regression model excluding social exclusion | | | | | | |
|---|---|---|---|---|---|---|
| **Source** | SS | df | MS | Number of obs. = | 205 | |
| | F(2, 202) = 131.66 | | | | | |
| | Adj R-squared = 0.5616 | | | | | |
| **Model** | 56.824 | 2 | 28.412 | Prob > F = | 0.000 | |
| **Residual** | 43.592 | 202 | . 216 | | | |
| **Total** | 100.416 | 204 | .492 | Root MSE = | .4645 | |
| **Variable** | **Coef.** | **Std. Err.** | **t** | **P>t** | **[95% Conf. Interval]** | |
| **X2** | -.132 | .056 | -2.37 | 0.019 | -.241 | -.022 |
| **X3** | .691 | .043 | 16.22 | 0.000 | .607 | .775 |
| **Constant** | 1.538 | .230 | 6.70 | 0.000 | 1.086 | 1.991 |

**Source:** Author's Compilation (2025)

Figure 5.14 illustrates the standardised coefficients (β) of both predictors (X2 and X3), with associated standard errors depicted as error bars to show the variability in the estimates.

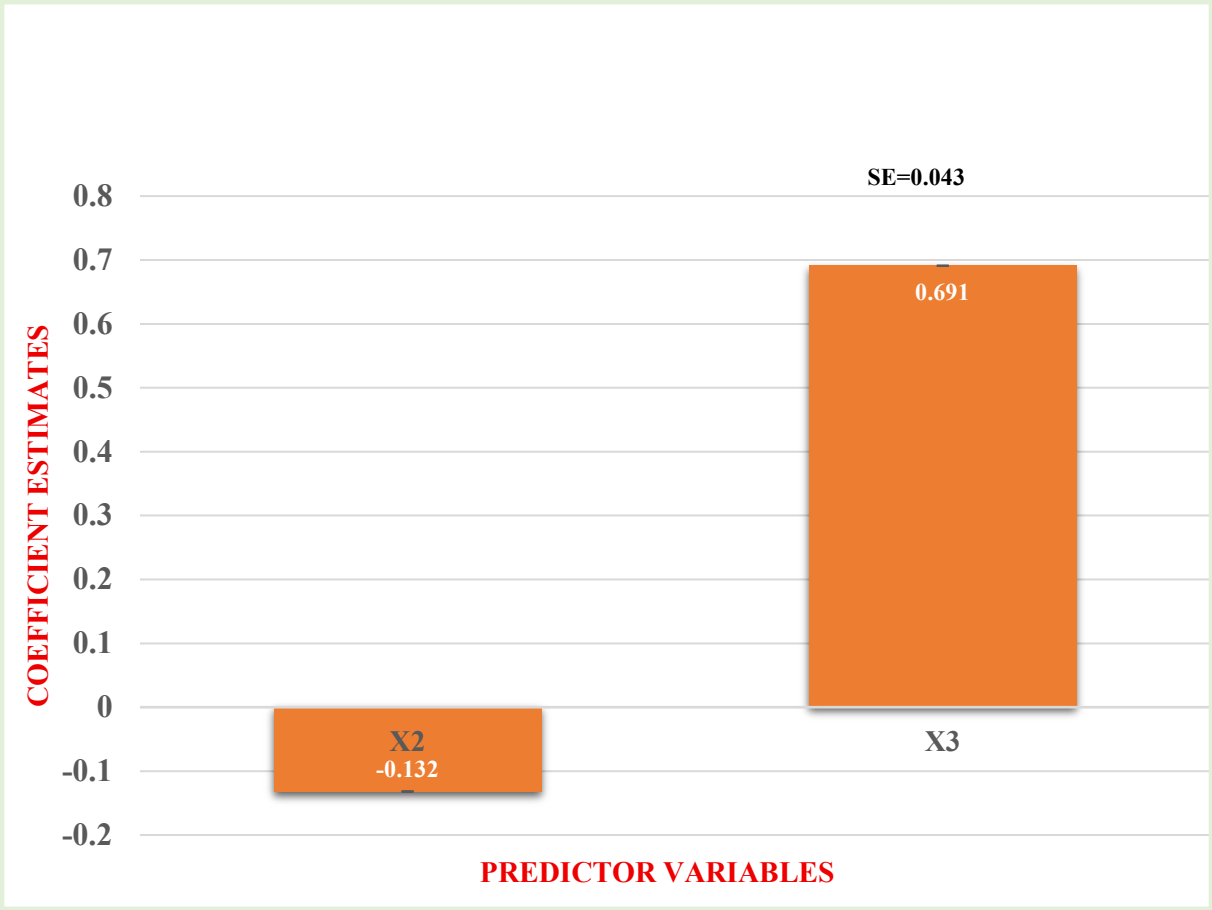


**Figure 5.14:** Regression coefficients (X2 and X3) with standard errors for predicting green ICT adoption

**Source:** Author's Compilation (2025)

Figure 5.14 complements the regression output by visually illustrating the relative influence and precision of each predictor variable on the dependent outcome. The height of each bar represents the unstandardised regression coefficient, while the error bars indicate the associated standard errors. This visual representation facilitates comparison of the strength and direction of the relationships; supporting the interpretation of the statistical contribution of each independent variable. The regression coefficients reflect the estimated direction and magnitude of the relationships between the independent variables and the dependent variable. In this model, X2 (challenges and barriers) has a negative coefficient ($\beta$ = -0.132), while X3 (employee awareness, involvement and perceptions) has a positive coefficient ($\beta$ = 0.691). The associated standard errors are 0.056 for X2 and 0.043 for X3, indicating relatively precise estimates. The p-values for X2 and X3 are 0.019 and 0.000, respectively—both below conventional significance thresholds ($p < 0.05$ and $p < 0.01$). The regression model yielded an F-statistic of 131.66, with a corresponding p-value of < 0.001, indicating overall statistical

significance. The adjusted R-squared value is 0.5616, suggesting that approximately 56% of the variance in the dependent variable is explained by the model. The root mean squared error (RMSE) is 0.4645, providing an additional indicator of the model's fit.

### 5.10.6 Hypothesis Testing:

***H3: A higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A.***

Hypothesis H3 proposed that a higher level of positive employee perception and active participation correlates with more successful implementation of Green ICT initiatives in Organisation A. To examine this relationship, a correlation and regression analysis were conducted. The correlation analysis between employee awareness, involvement and perceptions (X3) and the effectiveness and adoption of Green ICT practices (Y) produced a Pearson correlation coefficient of $r = 0.744$, indicating a strong linear relationship. This suggests that as employee perception and engagement levels increase, the reported levels of Green ICT implementation effectiveness tend to vary accordingly.

Furthermore, the multiple linear regression model reported in Table 5.24 (§5.10.5) included X3 as a predictor. The coefficient for X3 was $\beta = 0.691$, with a p-value of 0.000 and a standard error of 0.043. This indicates a statistically significant relationship between employee awareness/involvement and the dependent variable. The regression model reported an adjusted R-squared value of 0.5616, and the overall F-statistic was 131.66 ($p < 0.001$)**,** supporting the reliability of the regression equation. These values highlight the statistical relationship between employee-related constructs and implementation success within the model. The regression and correlation outputs provide quantitative support for examining the role of employee perception and involvement in Green ICT practices.

### 5.10.7 Hypothesis Testing:

**H4:** ***Strategic recommendations can effectively address and mitigate the challenges faced by Organisation A in their Green ICT transition.***

Hypothesis H4 proposed that strategic recommendations can effectively address and mitigate the challenges faced by Organisation A in their Green ICT transition. While this hypothesis is not statistically testable, it is addressed through the qualitative analysis of open-ended responses in Section F. The insights provided by respondents inform the basis for strategic proposals, which are further developed in Chapter 6 in alignment with secondary objective 4.

### 5.10.8 Summary: Correlation, regression analysis and hypothesis testing

This section outlined the regression analysis and hypothesis testing procedures applied to assess the statistical relationships between the study variables. Hypotheses H1, H2 and H3 were evaluated using inferential statistical methods aligned with the study's quantitative methodology and conceptual framework.

Hypothesis H1 was tested using a one-sample t-test to determine whether perceptions of Green ICT adoption significantly differed from a neutral benchmark. Hypotheses H2 and H3 were examined using multiple linear regression analysis to assess the predictive influence of readiness-related barriers and employee engagement on the effectiveness of Green ICT practices. Prior to regression analysis, multicollinearity diagnostics were conducted to ensure the reliability and validity of the model.

Each hypothesis was examined based on standard statistical indicators, including regression coefficients, t-values, p-values, confidence intervals and adjusted R-squared values. These analyses provide a structured basis for further interpretation in Chapter 6, which will present the key findings and formulate data-driven recommendations in line with the study's objectives.

## 5.11 CONCLUSION

Chapter 5 presented the comprehensive statistical analysis of data collected from 205 fully completed survey responses. The chapter systematically examined each section of the questionnaire, beginning with the demographic profile of respondents, followed by the detailed analyses of sections B to F and concluded with hypothesis testing. The demographic section provided context by describing the gender, age, job positions, work experience, departmental affiliation and educational qualifications of ICT professionals and managers at Organisation

A. Sections B, C, D and E were analysed using descriptive statistics (mean and standard deviation) and inferential statistics (one-sample t-tests), as outlined in the research methodology. These sections were structured around the GITAM framework constructs, categorising questionnaire variables according to technological, organisational and environmental dimensions. Correlation and regression analyses were conducted to test hypotheses H1, H2 and H3. A one-sample t-test was used to assess the current state of Green ICT adoption (H1), while multiple linear regression analysis evaluated the influence of readiness barriers and employee engagement on adoption effectiveness (H2 and H3). Multicollinearity diagnostics were applied to validate the regression model, resulting in the refinement of predictor variables. Hypothesis H4, related to strategic responses, was addressed descriptively based on respondents' suggestions gathered in Section F.

No conclusions or findings were drawn in this chapter. Rather, the statistical results lay the foundation for the interpretation of findings and formulation of recommendations, which are presented in Chapter 6.

# CHAPTER 6
# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 INTRODUCTION

The preceding chapter presented the statistical analysis and interpretation of results obtained through the online questionnaire. This chapter builds on these by presenting the conclusions and recommendations of the study. The conclusions are framed in relation to the research problem, research questions and objectives; thereby evaluating the extent to which these have been achieved.

The conclusions are guided by the four Green ICT constructs: Green IT Context, Green IT Readiness, Green IT Drivers and Intention to Adopt Green IT, as derived from the GITAM

framework discussed in Chapter 3. The overall structure and flow of this chapter are illustrated in Figure 6.1.

Accordingly, the chapter begins with a synopsis of the study and a restatement of the research problem. Section 6.4 provides a summary of the main findings, followed by conclusions pertaining to the research objectives drawn in relation to the primary and secondary objectives. Section 6.6 presents recommendations derived from these conclusions. The chapter then considers the study's limitations, delimitations, contributions to knowledge, managerial implications and suggestions for future research, before concluding.

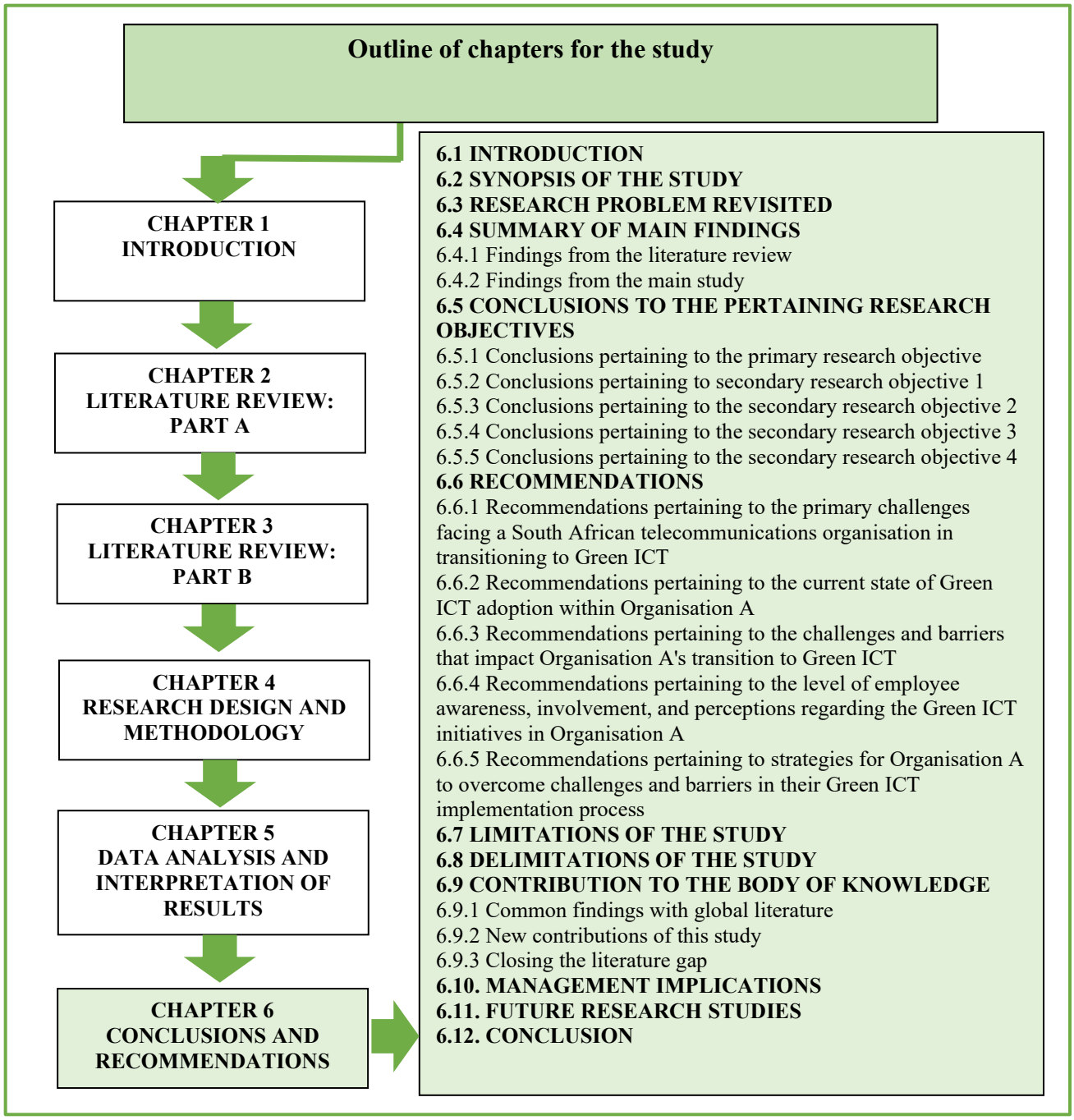

**Figure 6.1:** Outline of Chapter 6
**Source:** Author's compilation (2025)

The following section provides a synopsis of the study, offering a concise overview of the contents of each chapter.

## 6.2 SYNOPSIS OF THE STUDY

This study investigated the challenges faced by a South African telecommunication organisation in transitioning to Green ICT (GICT). A brief overview of each chapter is presented below.

**Chapter 1** introduced the study by outlining the background, rationale and significance of investigating Green ICT adoption. The research problem, aim, questions, objectives and hypotheses were presented, together with a summary of the research design and methodology. The chapter also highlighted the limitations of the study and concluded with an exposition of the chapters.

**Chapter 2** provided the first part of the literature review (Literature A), focusing on ICT and Green ICT globally, in a developing country and in the South African context. It examined the environmental impact of ICT, the benefits of Green ICT and the challenges and barriers to its adoption. Sustainable practices such as energy efficiency, renewable energy, e-waste management and network optimisation were discussed, along with the role of the telecommunications industry, its environmental footprint and Organisation A's sustainability commitments.

**Chapter 3** presented the second part of the literature review (Literature B), examining underpinning theories of technology adoption. Several models were evaluated, including the Theory of Reasoned Action, the Theory of Planned Behaviour, the Diffusion of Innovation Theory, the Unified Theory of Acceptance and Use of Technology, the Green Readiness Framework, the Technology Acceptance Model and the Technology–Organisation–Environment (TOE) framework. From this evaluation, the Green IT Adoption Model (GITAM) was selected as the primary framework because of its focus on Green ICT adoption. The TOE framework was retained as a complementary classification tool to organise variables into

technological, organisational and environmental frameworks. Together, these frameworks informed the development of the research constructs and guided the empirical analysis.

**Chapter 4** outlined the research design and methodology adopted in the study. The positivist philosophy and quantitative survey design were justified, followed by the descriptive research design and survey strategy. The population, sampling procedures and data collection processes were explained, including the design and administration of the questionnaire. A pilot study was conducted, and issues of validity, reliability, ethics, limitations, delimitations, assumptions and strategies to minimise bias were addressed.

**Chapter 5** presented the statistical analysis and results from 205 valid survey responses. The analysis began with the demographic profile of respondents before reporting on Sections B to F of the questionnaire. Using descriptive and inferential statistics, the results were structured according to the GITAM constructs and categorised under the technological, organisational and environmental framework. Hypotheses H1, H2 and H3 were tested using one-sample t-tests and multiple regression analysis, while section F provided qualitative insights addressing H4. Correlation analysis was conducted to examine the relationships between variables, while regression analysis tested the combined influence of different factors on Green ICT adoption.

**Chapter 6**, the present chapter, builds on these results by presenting the conclusions and recommendations of the study. It revisits the research problem, questions and objectives to evaluate the extent to which they were achieved; and further outlines the study's limitations, delimitations, contributions, managerial implications, recommendations for future research and conclusions.

## 6.3 RESEARCH PROBLEM REVISITED

The problem statement discussed in Chapter 1 (§1.2) (Atsu et al., 2021; Freitag et al., 2021) highlighted that, at a global level, ICT contributes significantly to environmental pressures. ICT-related emissions account for approximately 1,100 million tonnes of carbon emissions annually (Popli et al.,2021) and continue to grow at around 1.8% per year, equivalent to nearly 20% per decade (§2.3.5) (Freitag et al., 2021). These emissions, combined with increasing demand for ICT infrastructure, rising energy consumption and poor e-waste management,

underscore the urgency of transitioning towards sustainable ICT practices worldwide (§2.3.5) (Islam et al., 2020). Global climate negotiations, such as COP28, have reinforced the need to reduce reliance on fossil fuels and accelerate the adoption of renewable energy solutions (§2.3.5) (UNFCCC, 2023).

In SA, the telecommunications sector has expanded rapidly, with high levels of internet penetration and mobile growth contributing to its position as one of the most advanced ICT markets in Sub-Saharan Africa (§2.3.4) (ICASA, 2023). However, this expansion has been accompanied by significant energy consumption and increased carbon emissions, placing additional environmental pressures on the sector (§2.5.5) (Raihan, 2023). At the same time, telecommunications organisations are expected to align with regulatory requirements and sustainability commitments, which highlight the national imperative to transition towards a low-carbon economy (§2.5.6). Together, these factors illustrate the dual challenge facing the South African telecommunications sector: sustaining digital growth while addressing its environmental impact.

At the organisational level, despite Organisation A's commitment to sustainability, the company continues to face challenges and barriers in meeting its environmental targets (§1.5) (Integrated Report, 2023). The following explains the linkage of the main research question to the research problem:

- *What are the primary challenges facing a South African telecommunication organisation in transitioning to green ICT?*

This was explored in Chapter 5. In doing so, the study directly addressed the research problem, which had highlighted that, despite Organisation A's sustainability commitments, the organisation continues to face significant challenges in transitioning to Green ICT that were not adequately understood (§1.5). The statistical findings presented in Chapter 5 (§5.5–§5.10) detailed the barriers, readiness factors and employee perspectives influencing Green ICT adoption. By answering the main research question and achieving the primary research objective in Chapter 5 (§5.11), the research problem was addressed. The challenges facing Organisation A in its transition to Green ICT are now better understood.

## 6.4 SUMMARY OF MAIN FINDINGS

This section presents the key findings of the study, drawing first on the insights gained from the literature review and then on the results of the empirical investigation in Chapter 5. The summary is organised to highlight the main research question and its related sub-questions, providing a clear link between the reviewed literature and the study's primary outcomes.

### 6.4.1 Findings from the literature review

A literature review is a critical component of a study, as it enables the researcher to present arguments and highlights gaps regarding the main and sub-constructs of the research. This section presents the findings from the reviewed literature. The literature indicated that the four main constructs of the GITAM: Green IT Context, Green IT Readiness, Green IT Drivers and Intention to Adopt Green IT were closely aligned with the research problem, the research questions and the objectives of this study (§1.6; §1.7); while the TOE framework provided an additional lens to categorise the factors influencing Green ICT adoption. The review incorporated both local and international studies relevant to Green ICT adoption in the telecommunications sector (§2.4–§2.5). Specifically, it examined the environmental impact of ICT (§2.3.5) and of the telecommunications industry (§2.5.5); the role of Green ICT practices and technologies (§2.4.4) and the challenges and barriers to adoption, globally and within SA (§2.4.3; §2.4.5; §2.3.4).

The reviewed literature highlighted that ICT serves as both a driver of economic development and a contributor to environmental burdens. The findings demonstrated that ICT expansion has led to high energy consumption, significant carbon emissions and growing concerns around e-waste (§2.3.5). These impacts underline the urgency of sustainable alternatives within the ICT sector.

The literature further revealed that Green ICT has the potential to address these concerns by promoting energy efficiency, integrating renewable energy solutions and improving waste management (§2.4). Such practices were found to support both environmental and operational goals, making them strategically important for organisations transitioning to sustainable ICT models.

The findings showed that there are several challenges and barriers to Green ICT adoption globally (§2.4.3), including cultural resistance, financial constraints, inadequate regulatory frameworks and limited technical readiness. Within the South African context, the literature identified specific challenges related to energy dependency, infrastructure limitations and organisational readiness (§2.3.4; §2.4.3). Organisation A was also found to face unique barriers, particularly in terms of operational costs, energy reliance and the integration of sustainability into its strategic framework (§2.6).

Overall, the findings from the literature review established the conceptual foundation for this study; demonstrating that, while ICT is indispensable for economic and social development, it also poses significant environmental challenges. Green ICT, therefore, emerges as both a necessity and an opportunity, with the reviewed literature emphasising that its adoption is critical for advancing sustainable ICT practices within Organisation A and the broader telecommunications sector.

### 6.4.2 Findings from the main study

The empirical analysis presented in Chapter 5 provided quantitative evidence of the barriers and drivers of GICT adoption in Organisation A. Using descriptive statistics, one-sample t-tests, correlation and regression analysis, the study examined responses from 205 employees. The findings are summarised according to the research questions:

#### *6.4.2.1 Findings from the main research question*

- *What are the primary challenges facing a SA telecommunication organisation in transitioning to green ICT?*

The findings for the main research question are drawn from Construct 1: Green IT Context of the GITAM model (§3.9.2), which specifically examines the primary challenges to Green ICT adoption within Organisation A across the three dimensions of the TOE framework: technological, organisational and environmental. The findings indicated that Organisation A experiences a mix of barriers and enablers across the three dimensions of the TOE framework, embedded within Construct 1: Green IT Context of the GITAM model (§3.9.2). The findings are presented below:

- **Technological factors**

The findings indicated mixed perceptions regarding ICT infrastructure (B13), with only 45.37% agreeing that it is adequate for supporting Green ICT adoption, suggesting partial readiness. The financial burden of implementation (B14) was identified as the most pronounced technological barrier, with 62.44% agreement; highlighting cost as a primary challenge. Departmental readiness (B15) was less conclusive, with 39.51% agreement, reflecting uneven preparedness across business units.

- **Organisational factors**

The findings indicated that cultural and social challenges (B1) were moderately recognised as barriers, with 51.22% agreement. Knowledge and communication challenges (B2) were more strongly affirmed, with 67.81% agreement. Employees' reluctance to change (B4) was less decisive, with only 43.91% agreement, showing weaker support compared to other variables. Cultural norms (B5) were also identified as limiting factors, with 47.32% agreement. Leadership support (B6) was overwhelmingly endorsed as essential, with 89.26% agreement, making it the strongest organisational enabler. Understanding of Green ICT principles (B7) was inconclusive, with 37.56% agreement, indicating uncertainty about employees' grasp of key concepts. Communication strategies (B8) received partial support, with 41.46% agreement on their effectiveness. Finally, lack of training (B9) emerged as a major organisational barrier, with 76.58% agreement.

- **Environmental factors**

The findings indicated that market and demand challenges (B3) were widely recognised as barriers, with 70.25% agreement, highlighting demand-side pressures as a critical obstacle to adoption. Customer expectations (B10) were affirmed as an external driver, with 60.49% agreement, showing that market expectations play an influential role in shaping the organisation's strategy. At the same time, lack of market demand (B11) was identified as a substantial barrier, with 63.91% agreement, underscoring a contradiction between expectations

and actual demand. Industry competition (B12) was also considered influential, with 56.59% agreement, reflecting the role of external pressures in shaping Green ICT implementation.

***Summary:*** The findings from the analysis indicate that Green ICT adoption in Organisation A is shaped by both constraints and enablers across the TOE frameworks. Cost-related concerns (B14), limited training provision (B9) and market pressures (B3, B11) emerged as the strongest barriers, while leadership support (B6) and customer expectations (B10) were affirmed as important enablers of adoption. Other factors, such as ICT infrastructure (B13), departmental readiness (B15) and cultural norms (B5), reflected partial or mixed perceptions, highlighting uneven preparedness across the organisation. Overall, the findings showed that the state of adoption remains incomplete, consistent with Hypothesis H1. At the same time, the results demonstrated how GITAM's Green IT Context provides a useful framework for examining the barriers, challenges and enablers influencing Organisation A's transition to Green ICT (§5.5.4).

#### *6.4.2.2 Findings from research sub-question 1*

- *What is the current state of green ICT adoption within Organisation A?*

The findings for Research Sub-Question 1 are drawn from Construct 1: Green IT Context and Construct 3: Drivers of Green IT of the GITAM model (§3.9.2; §3.9.4), which specifically examine the current state of Green ICT adoption within Organisation A across the three dimensions of the TOE framework: technological, organisational and environmental.

The findings indicated that adoption within Organisation A is uneven across the three dimensions of the TOE framework, embedded within Construct 1 and Construct 3 of the GITAM model. The findings are presented below:

- **Technological factors**

The findings indicated that Organisation A's Green ICT practices (C1) were recognised as beneficial, with 69.76% agreeing that they reduce environmental impact. Energy efficiency practices (C3a) showed weaker adoption, with only 44.88% agreement, reflecting partial effectiveness. Sustainable design and production (C3b) received moderate support, with

49.75% agreement, indicating uneven adoption. E-waste management (C3c) was less effective, with 41.95% agreement, highlighting it as a key technological challenge. Renewable energy adoption (C3d) was similarly limited, with 40.97% agreement, pointing to readiness gaps. By contrast, strong support was found for virtualisation (C3e), with 62.92% agreement, and remote work practices (C3f), with 82.93% agreement, positioning them as the strongest technological enablers. Network efficiency improvements (C3g) were also positively recognised, with 76.58% agreement, reinforcing this as another strong enabler of Green ICT adoption.

- **Organisational factors**

The findings indicated that departmental readiness (C2) was weak, with only 27.31% agreeing that Green ICT initiatives are regularly reviewed and updated, suggesting limited consistency. Policy awareness (C4) was partial, with 38.05% agreement, showing that not all employees felt adequately informed of guidelines. Resource provision (C5) was also insufficient, with only 33.17% agreement that the organisation provides adequate support for adoption. Monitoring and evaluation (C6) was limited, with just 27.32% agreement, highlighting a lack of systematic assessment of initiatives. Training and development (C7) emerged as the weakest factor, with only 24.39% agreement that sufficient training is provided, making it a significant organisational barrier.

- **Environmental factors**

The findings indicated that green standards and policies within departments (C3h) were weak, with only 27.56% agreeing that such policies are effective, while a large proportion remained undecided, pointing to inconsistent application across units. Research and innovation practices in departments (C3i) were more positively recognised, with 47.80% agreement that such initiatives are effective, reflecting partial departmental support for Green ICT adoption.

***Summary***: The findings from the analysis indicate that Green ICT adoption in Organisation A is shaped by both barriers and enablers across the TOE categories. The strongest technological enablers were virtualisation (C3e), remote work practices (C3f) and network efficiency improvements (C3g), while weak adoption in energy efficiency (C3a), sustainable design and production (C3b), e-waste management (C3c) and renewable energy adoption (C3d) emerged

as key barriers. Within the organisational dimension, training and development (C7), monitoring and evaluation (C6) and departmental readiness (C2) were identified as the weakest areas, while policy awareness (C4) and resource provision (C5) reflected only partial support. For environmental factors, departmental green standards and policies (C3h) remained weak, while research and innovation practices (C3i) showed moderate support as a potential enabler. Overall, the findings indicated that the state of adoption remains partial and uneven, consistent with Hypothesis H3. At the same time, the results demonstrated how GITAM's Green IT Context and Drivers of Green IT provide a useful framework for examining the barriers and enablers influencing Organisation A's transition to Green ICT (§5.6.2).

#### *6.4.2.3 Findings from research sub-question 2*

- *What are the specific challenges and barriers that impact Organisation A's transition to green ICT?*

The findings for this sub-question are drawn from Construct 2: Green IT Readiness of the GITAM model (§3.9.3), which examines the preparedness of Organisation A and the challenges or barriers influencing its transition to Green ICT. The construct is analysed across the three dimensions of the TOE framework: technological, organisational and environmental.

The findings indicated that Organisation A faces a wide range of challenges across all three TOE categories, constraining its readiness for adoption. The findings are presented below:

- **Technological factors**

The findings indicated that technical and infrastructure barriers (D3) were widely recognised as hindering the organisation's ability to adopt Green ICT, with 57.56% agreement. Technical limitations of the existing ICT infrastructure (D10) were also identified as a barrier, with 49.76% agreement. Departmental sufficiency of infrastructure (D11) was less conclusive, with only 36.59% agreement, suggesting partial readiness at the departmental level. The need for modern technology investment (D12) was confirmed as a substantial barrier, with 61.95% agreement, while the cost of upgrading infrastructure (D13) emerged as the most pronounced

barrier, with 72.68% agreement, underscoring financial constraints as a major impediment to adoption.

- **Organisational factors**

The findings indicated that general readiness challenges (D1) were recognised as barriers, with 59.99% agreement. Organisational and strategic barriers (D2) were also affirmed, with 52.68% agreement, highlighting structural and strategic shortcomings. Financial barriers (D4) were identified as a substantial impediment, with 66.83% agreement, reinforcing the role of resource constraints. The lack of strategic alignment across departments (D7) was confirmed as a major barrier, with 65.85% agreement, underscoring inconsistencies in organisational direction. Leadership prioritisation of Green ICT (D8) was weaker, with 45.37% agreement, indicating only partial endorsement from leadership. Departmental coordination (D9) was also highlighted as a barrier, with 58.05% agreement, pointing to weaknesses in collaboration across units. Finally, limited financial resources (D14) emerged as one of the strongest barriers, with 70.24% agreement, emphasising funding limitations as a critical organisational challenge.

- **Environmental factors**

The findings indicated that policy and regulatory barriers (D5) were less conclusive, with 27.32% agreement, reflecting uncertainty about the effectiveness of external policy frameworks. External and physical barriers (D6), such as operational constraints, were widely acknowledged, with 59.02% agreement, underscoring their significance in hindering adoption. Compliance with international standards (D15) was only partially affirmed, with 47.32% agreement, highlighting limited progress in aligning with global benchmarks. External operational factors such as power outages and loadshedding (D16) were strongly confirmed as barriers, with 61.95% agreement, while geographical challenges (D17) were also recognised, with 65.36% agreement, pointing to the influence of location and infrastructure limitations on adoption.

***Summary:*** The findings from the analysis indicate that Organisation A's readiness for Green ICT adoption is constrained by barriers across all three TOE categories. Financial barriers, both in terms of cost of upgrades (D13) and limited resources (D14), together with operational

obstacles such as loadshedding (D16) and geographical constraints (D17), emerged as the strongest impediments. More mixed responses in areas such as infrastructure sufficiency (D11), regulatory frameworks (D5) and international compliance (D15) highlighted areas of partial readiness. Overall, the analysis showed that the state of readiness remains constrained, consistent with Hypothesis H2, while also pointing to opportunities for improvement. These findings demonstrate how GITAM's Green IT Readiness construct provides a structured framework for examining the barriers and enablers shaping Organisation A's transition to Green ICT (§5.7.2).

#### *6.4.2.4 Findings from research sub-question 3*

- *What is the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A?*

The findings for Research Sub-Question 3 are drawn from Construct 3: Green IT Drivers of the GITAM model (§3.9.4), which specifically examines the internal and external motivational factors influencing Green ICT adoption in Organisation A. These were assessed across the organisational and environmental dimensions of the TOE framework.

- **Organisational factors**

The findings indicated that perceptions of Green ICT drivers within Organisation A were uneven, with evidence of both enabling factors and constraints across the two TOE frameworks. Awareness of Green ICT initiatives (E1) was affirmed, with 52.68% agreement, indicating a moderate level of recognition. Employee involvement (E2) was weaker, with only 26.34% agreement, showing limited participation. Communication effectiveness (E4) was inconclusive, with 31.21% agreement, as responses were distributed across categories and the mean score (2.9) was not statistically significant. Organisational culture (E5) recorded 47.81% agreement, while strategic alignment (E6) showed 50.25% agreement, both reflecting partial support for adoption. Departmental engagement (E7) recorded 34.15% agreement, pointing to uneven participation across business units. Finally, organisational commitment (E8) recorded 54.64% agreement, making it the strongest driver within this framework.

- **Environmental factors**

The findings indicated that sustainability and environmental impact (E3) recorded 50.73% agreement, indicating that respondents viewed Green ICT initiatives as contributing positively to organisational sustainability. Stakeholder engagement (E9) recorded 37.56% agreement, with a high proportion of undecided responses (46.83%), reflecting limited clarity on the extent of stakeholder involvement in supporting Green ICT initiatives.

***Summary:*** The findings from the analysis indicate that Green ICT drivers within Organisation A are characterised by both strengths and limitations. Awareness (E1), organisational commitment (E8) and alignment with strategic goals (E6) emerged as the strongest internal drivers, while weaker perceptions of employee involvement (E2), departmental engagement (E7) and communication effectiveness (E4) constrained momentum. Externally, sustainability impact (E3) was affirmed, but stakeholder engagement (E9) reflected greater uncertainty. Overall, the findings show that while enabling factors exist, gaps in participation and engagement continue to limit the full effectiveness of Green ICT drivers. These results provide empirical support for Hypothesis H3, which posited that employee awareness, involvement and perceptions significantly influence the success of Green ICT adoption within Organisation A (§5.8.2).

#### *6.4.2.5 Findings from research sub-question 4*

- *What strategies can be recommended to Organisation A to address both challenges and barriers in their Green ICT implementation process?*

The findings for research sub-question 4 are derived from the qualitative responses captured in section F of the questionnaire, as analysed in chapter 5 (§5.9)**.** In this section, respondents provided open-ended recommendations on strategies to strengthen Organisation A's transition to Green ICT. Unlike earlier sections, no statistical analysis was applied; instead, the responses were systematically reviewed and grouped across the TOE framework to reflect the collective insights of respondents.

- **Technological factors**

The findings indicated that respondents recommended upgrading ICT infrastructure, investing in modern technologies and ensuring energy efficiency across operations. Suggestions included adopting renewable energy for base stations, improving site design for passive cooling and heat exchange and leveraging innovative solutions such as AI for predictive maintenance. Respondents further emphasised investment in cloud computing, virtualisation and recycling practices, alongside regular monitoring and reporting of ICT performance.

- **Organisational factors**

The findings indicated that a strong emphasis was placed on leadership commitment, with calls for visible top management support, the appointment of a Green ICT ambassador or team and clear integration of sustainability into organisational strategy. Respondents highlighted the importance of communication and awareness campaigns, respondent involvement and comprehensive training programmes to build capacity. Adequate budgeting and resource allocation were also identified as essential, together with strategic alignment across departments, cross-functional collaboration and the development of a sustainability-focused organisational culture.

- **Environmental factors**

The findings indicated that respondents highlighted the need to address operational barriers such as loadshedding, vandalism and theft of ICT infrastructure, while also calling for proactive contingency planning to ensure resilience. Policy development and compliance with international standards were identified as critical to aligning organisational practices with global sustainability expectations. External collaboration was also seen as important, including partnerships with suppliers, government and industry groups, as well as engagement with local communities and customers to build broader support for Green ICT adoption.

***Summary:*** The findings indicated that respondents perceived a range of strategies across all three TOE frameworks as essential for overcoming existing challenges and accelerating adoption. These insights, as reported in Chapter 5 (§5.9), provide a qualitative complement to

the quantitative findings discussed earlier and directly inform the conclusion presented in Chapter 6.

## 6.5 CONCLUSIONS PERTAINING TO THE RESEARCH OBJECTIVES

This section presents the overall conclusions of the study by linking the findings in Chapter 6 with the conceptual foundations outlined in Chapter 2 and the TOE framework and GITAM model introduced in Chapter 3. Challenges, as defined in Chapter 2 (§2.4.3.1), are circumstances that require effort and perseverance to overcome; while barriers (§2.4.3.2) are impediments that obstruct or prevent progress. The following sub-sections present the conclusions for each research objective, beginning with the primary research objective.

### 6.5.1 Conclusions pertaining to the primary research objective

• *To identify the primary challenges facing a South African telecommunication organisation in transitioning to Green ICT.*

Based on the analysis, results and findings the following conclusions are presented based on the three dimensions of the TOE framework: technology, organisational and environmental:

- **Technological factors**

It can be concluded that Organisation A faces both challenges and barriers in the technological framework. The financial burden of implementing Green ICT (B14) was identified as a key barrier, directly constraining investment capacity. Uneven departmental readiness (B15) represented an ongoing challenge, highlighting inconsistencies across units that could be improved with targeted effort. The adequacy of ICT infrastructure (B13) reflected mixed perceptions, suggesting partial readiness and therefore a challenge rather than a barrier. At the same time, infrastructural preparedness provided evidence of an enabler that could support future adoption.

- **Organisational factors**

It can be concluded that internal organisational barriers and challenges hinder adoption. Cultural and social resistance (B1) and entrenched organisational norms (B5) were identified as barriers that obstruct adoption. Limited training opportunities (B9) also emerged as a significant barrier restricting capacity. Knowledge and communication gaps (B2, B7) reflected challenges, as they represent weaknesses that could be addressed through improved awareness and engagement. Employees' reluctance to change (B4) was less decisive compared to other factors but still presented a challenge requiring sustained effort to overcome. Communication strategies (B8) were found to promote Green ICT awareness only moderately effectively, indicating the need for stronger and more consistent approaches to awareness-building across the organisation. Leadership support (B6) was strongly recognised as essential, positioning it as a critical enabler for driving organisational commitment and facilitating the transition to sustainable ICT practices.

- **Environmental factors**

It can be concluded that external pressures significantly affect adoption. Lack of market demand (B11) and industry competition (B12) were highlighted as barriers that limit the organisation's ability to prioritise sustainability. Market and demand pressures (B3) were better understood as challenges, requiring ongoing adaptation to changing dynamics. At the same time, customer expectations (B10) were identified as a positive enabler, providing external motivation for Organisation A to strengthen its Green ICT initiatives.

***Summary:*** Therefore, it can be concluded that Organisation A's adoption of Green ICT is shaped by a combination of barriers, challenges and enablers across the TOE frameworks. Barriers such as financial constraints, entrenched norms, limited training, lack of market demand and industry competition obstruct adoption, while challenges such as readiness, communication gaps and employee resistance require sustained effort to overcome. Enablers such as infrastructural preparedness, perceived leadership commitment and customer expectations provide a foundation for future progress. Accordingly, the primary research objective was achieved, as the study identified and evaluated the major challenges, barriers and enablers influencing Green ICT adoption within Organisation A, confirming that adoption is currently suboptimal across all three TOE frameworks and consistent with Hypothesis H1.

### 6.5.2 Conclusions pertaining to secondary research objective 1

• *To evaluate the current state of Green ICT adoption within Organisation A.*

Based on the findings in Chapter 6, the following conclusions are presented:

- **Technological factors**

It can be concluded that technological adoption within Organisation A is uneven. Virtualisation (C3e), remote work practices (C3f) and network efficiency (C3g) emerged as strong enablers, demonstrating domains where adoption is progressing effectively. By contrast, energy efficiency (C3a), sustainable design and production (C3b), e-waste management (C3c) and renewable energy (C3d) reflected weaker or partial adoption, representing ongoing challenges that demand greater effort. These gaps also act as barriers to full technological integration, limiting Organisation A's ability to achieve consistent progress. While the general perception that ICT practices reduce environmental impact (C1) confirmed the potential of technological initiatives, the inconsistency across technological domains indicated that overall technological readiness remains incomplete.

- **Organisational factors**

It can be concluded that organisational readiness is limited. Departmental review and updating of initiatives (C2) were weak, while awareness of policies (C4) and provision of resources (C5) showed only partial support, representing ongoing challenges to adoption. Monitoring and evaluation (C6) were underdeveloped and training and development opportunities (C7) were identified as the weakest factor, both acting as critical barriers that obstruct progress. These shortcomings highlight the lack of systematic readiness, support and training within the organisation. Although enablers were less visible in this category compared to technology, the partial awareness of policies (C4) can be seen as an enabler in development, offering a basis that could be strengthened to improve organisational adoption of Green ICT.

- **Environmental factors**

It can be concluded that environmental integration is not yet fully developed. Green standards and policies (C3h) were rated weakly, with a large portion of respondents undecided, reflecting inconsistency in application across departments. This represents an ongoing challenge, as weak or unclear policy adoption requires considerable effort to address. Research and innovation (C3i) were more positively perceived but remained only partially effective, reflecting both a barrier in terms of insufficient embedding across the organisation and an emerging enabler where innovative practices have the potential to support stronger adoption if scaled consistently.

***Summary*:** Therefore, it can be concluded that the current state of Green ICT adoption in Organisation A remains partial and uneven across the TOE frameworks. While certain technological practices such as virtualisation, remote work and network efficiency serve as clear enablers, organisational shortcomings (limited readiness, insufficient training, weak monitoring) and environmental gaps (inconsistent standards and policies) represent ongoing challenges that require effort to overcome. At the same time, barriers such as lack of systematic support and inadequate alignment restrict consistent adoption. Accordingly, the secondary research objective 1 was achieved, as the study identified the extent of adoption within Organisation A, confirming that adoption is incomplete and supporting Hypothesis H3.

### 6.5.3 Conclusions pertaining to the secondary research objective 2

- *To investigate the challenges and barriers that impact Organisation A's transition to Green ICT.*

Based on the findings in chapter 6, the following conclusions are presented:

- **Technological factors**

It can be concluded that Organisation A faces substantial technological constraints. The cost of upgrading infrastructure (D13) and the need for modern technology investments (D12) emerged as strong barriers, directly obstructing progress unless resolved. Technical and infrastructure barriers (D3) as well as limitations of the existing ICT infrastructure (D10) were also confirmed as barriers that complicate adoption. Departmental sufficiency of infrastructure (D11), however, represented an ongoing challenge, reflecting uneven readiness across units

that requires sustained effort to improve. At the same time, partial sufficiency in some departments offered an emerging enabler, as it provides a base upon which stronger adoption could be built.

- **Organisational factors**

It can be concluded that internal organisational constraints hinder readiness. General readiness challenges (D1) and organisational and strategic barriers (D2) reflected weaknesses in structure and strategy, acting as barriers to effective adoption. Financial barriers (D4) and limited financial resources (D14) also emerged as strong barriers, highlighting persistent funding constraints. Misalignment across departments (D7) and lack of coordination (D9) were confirmed as critical barriers obstructing consistent implementation. Leadership prioritisation of Green ICT (D8) was only partially affirmed, representing an ongoing challenge that demands greater commitment at the strategic level.

- **Environmental factors**

It can be concluded that external pressures significantly affect readiness. Policy and regulatory barriers (D5) were identified as barriers, reflecting uncertainty about the effectiveness of external frameworks. External and physical barriers (D6), operational constraints such as loadshedding (D16) and geographical challenges (D17) were also confirmed as major barriers, underscoring the extent to which external conditions hinder adoption. Compliance with international standards (D15) was only partially achieved, representing an ongoing challenge that requires sustained effort to align with global benchmarks.

***Summary:*** Therefore, it can be concluded that Green ICT readiness in Organisation A is shaped by a dual reality of barriers and challenges. Financial constraints, strategic misalignment and external operational pressures dominate as barriers that obstruct progress, while challenges such as infrastructure sufficiency, policy uncertainty and leadership prioritisation require sustained effort to overcome. At the same time, partial compliance with standards and departmental infrastructure capacity suggest areas of emerging readiness that could serve as enablers if strengthened. Accordingly, the secondary research objective 2 was achieved, as the study identified and evaluated the major challenges and barriers influencing Organisation A's

transition to Green ICT, confirming that readiness remains constrained across all three TOE frameworks and consistent with Hypothesis H2.

### 6.5.4 Conclusions pertaining to the secondary research objective 3

- *To determine the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A.*

Based on the findings in Chapter 6, the following conclusions are presented:

- **Organisational factors**

It can be concluded that perceptions of Green ICT drivers within Organisation A were mixed. Awareness of Green ICT initiatives (E1) and organisational commitment (E8) emerged as strong enablers, with more than half of respondents affirming recognition and commitment, suggesting that these drivers provide a foundation for advancing adoption. Importantly, organisational culture (E5) was also identified as a positive enabler, with the majority of respondents indicating that the prevailing culture within Organisation A is supportive of Green ICT practices. Strategic alignment (E6) was partially affirmed, representing an ongoing challenge that requires further effort to embed Green ICT objectives across business units. By contrast, limited employee involvement (E2), weak departmental engagement (E7) and inconclusive communication effectiveness (E4) were identified as challenges, as they highlight areas of weakness that demand sustained improvement. Collectively, these organisational challenges reduce momentum for Green ICT adoption, though the presence of enabling factors such as awareness and commitment shows that progress is possible if gaps are addressed.

- **Environmental factors**

It can be concluded that environmental drivers were unevenly perceived. Sustainability and environmental impact (E3) was affirmed as an enabler, with more than half of respondents recognising the value of Green ICT in supporting organisational sustainability. However, stakeholder engagement (E9) reflected uncertainty, with many respondents' undecided,

making it a challenge that requires stronger involvement and clearer communication to be effective.

***Summary:*** Therefore, it can be concluded that employee-related drivers of Green ICT adoption in Organisation A are characterised by a combination of enablers and challenges. Enablers such as awareness, organisational culture, organisational commitment and recognition of sustainability impact provide a positive foundation, while challenges such as limited employee involvement, departmental engagement, weak communication and stakeholder uncertainty restrict progress. Accordingly, the secondary research objective 4 was achieved, as the study identified the level of employee awareness, involvement and perceptions regarding Green ICT initiatives in Organisation A, confirming that while enabling factors exist, participation gaps and communication weaknesses constrain overall effectiveness. These conclusions are consistent with Hypothesis H3.

### 6.5.5 Conclusions pertaining to the secondary research objective 4

- *To recommend strategies for Organisation A to overcome the challenges and barriers to Green ICT implementation***.**

Based on the findings in Chapter 6, the following conclusions are presented:

- **Technological factors**

It can be concluded that Organisation A's technological readiness is constrained by barriers such as outdated infrastructure and the high cost of renewable energy adoption. To address these challenges, respondents suggested strategies including phased modernisation of infrastructure, investment in renewable technologies and the adoption of innovative solutions such as cloud computing and artificial intelligence. These strategies were highlighted as opportunities to overcome technological limitations and build stronger capacity for sustainable ICT adoption.

- **Organisational factors**

It can be concluded that organisational barriers such as limited leadership prioritisation, weak alignment across departments and insufficient resourcing continue to obstruct adoption of Green ICT. To address these issues, respondents recommended strategies including stronger leadership accountability, enhanced cross-departmental governance structures and improved budget allocation to support initiatives. Challenges such as poor communication, restricted employee involvement and inadequate training require sustained interventions, with strategies focused on awareness-building campaigns, participatory programmes and ongoing capacity development. Enablers such as leadership commitment, cross-departmental collaboration and cultural integration of sustainability provide a foundation upon which these strategies can be effectively implemented.

- **Environmental factors**

It can be concluded that environmental barriers such as loadshedding, vandalism and theft directly obstruct the progress of Green ICT adoption, while regulatory uncertainty and limited stakeholder engagement represent ongoing challenges that require proactive management. To address these constraints, respondents recommended strategies including investment in resilient infrastructure, collaboration with policymakers to clarify regulatory requirements and the development of stakeholder engagement frameworks that involve communities, suppliers and customers. Enablers such as compliance with international standards, stronger industry partnerships and closer community engagement provide essential avenues to support environmental alignment and accelerate the transition to Green ICT.

***Summary:*** Therefore, it can be concluded that the strategies identified by respondents are closely tied to the barriers and challenges highlighted earlier in the study. Barriers such as financial and operational constraints, weak leadership prioritisation and external risks were reaffirmed, while challenges such as communication, awareness and uneven participation were underscored as requiring organisational effort. At the same time, enabling factors such as leadership commitment, modernisation of infrastructure and external collaboration provide opportunities for Organisation A to strengthen its transition to Green ICT. Accordingly, the secondary research objective 4 was achieved, as the study identified the range of strategic areas that can inform recommendations in the following section.

## 6.6 RECOMMENDATIONS

This section provides recommendations aligned with the study's objectives, linking directly to the conclusions presented in Section 6.5. The recommendations are structured around the three TOE frameworks: technological, organisational and environmental. The recommendations are designed to address the identified barriers that obstruct adoption, the challenges that require sustained effort to overcome and the enablers that can be leveraged to accelerate progress. By aligning barriers and challenges with targeted strategies and by capitalising on existing enablers, Organisation A can strengthen its transition to Green ICT in a systematic and sustainable manner.

### 6.6.1 Recommendations pertaining to the primary challenges facing a South African telecommunication organisation in transitioning to Green ICT

This section provides recommendations to address the primary challenges facing Organisation A in its transition to Green ICT, as identified in Section 6.5.1. The recommendations are presented in table form and aligned with the TOE framework to address barriers, challenges and enablers.

**Table 6.1: Recommendations to address the primary challenges facing a South African telecommunication organisation in transitioning to Green ICT (Primary Objective)**

| TOE Framework | Barriers/Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| **Technological** | • High financial burden of Green ICT (B14) – Barrier<br>• Uneven departmental readiness (B15) – Challenge<br>• Mixed adequacy of ICT infrastructure (B13) – Challenge | • Secure dedicated budget allocations and explore external green financing models (B14).<br>• Implement phased ICT upgrades to address readiness gaps across departments (B15).<br>• Conduct regular infrastructure audits to improve adequacy and reduce uncertainty (B13). | • Infrastructural preparedness (B13) provides a base for scaling future adoption. |
| **Organisational** | • Cultural/social resistance (B1) and entrenched norms (B5) – Barriers<br>• Limited training opportunities (B9) – Barrier<br>• Knowledge/communication gaps (B2, B7,B8) – Challenges<br>• Employee reluctance to change (B4) – Challenge | • Launch structured change-management programmes to address resistance (B1, B5).<br>• Develop comprehensive Green ICT training initiatives (B9).<br>• Improve internal communication strategies and awareness campaigns (B2, B7,B8).<br>• Introduce incentives to | • Leadership support (B6) was strongly recognised as essential to overcoming cultural resistance and enabling Green ICT implementation. Strengthening this support through visible top-management commitment, such as the establishment of a Green ICT |

| TOE Framework | Barriers/Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| | | encourage employee participation (B4). | steering committee, could further accelerate adoption. |
| **Environmental** | • Lack of market demand (B11) – Barrier<br>• Industry competition (B12) – Barrier<br>• Market and demand pressures (B3) – Challenge | • Engage with regulators and industry forums to stimulate demand and define clear sustainability standards (B11).<br>• Explore collaborative industry partnerships to reduce competitive disadvantages (B12).<br>• Adapt strategies to address shifting market dynamics through green product/service differentiation (B3). | • Customer expectations (B10) provide strong leverage to position Organisation A as a sustainability leader. |

**Source:** Author's Compilation (2025)

The following section presents the study's recommendations pertaining to Secondary Research Objective 1.

### 6.6.2 Recommendations pertaining to the current state of Green ICT adoption within Organisation A

This section provides recommendations to strengthen the current state of Green ICT adoption within Organisation A, as identified in Section 6.5.2. The recommendations are presented in table form and aligned with the TOE framework to address challenges, barriers and enablers.

**Table 6.2: Recommendations to strengthen the current state of Green ICT adoption in Organisation A (Secondary Objective 1)**

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| **Technological** | • Weak adoption of energy efficiency (C3a) – Challenge<br>• Limited sustainable design practices (C3b) – Challenge<br>• Inconsistent e-waste management (C3c) – Challenge<br>• Partial renewable energy integration (C3d) – Challenge | • Prioritise targeted investment in weaker domains – energy efficiency (C3a), e-waste management (C3c), sustainable design (C3b) and renewable energy within departments (C3d).<br>• Establish integrated performance tracking across ICT domains (C3a–C3d).<br>• Expand renewable energy pilots and recycling initiatives | • Strong adoption of virtualisation (C3e), remote work (C3f) and network efficiency (C3g) can serve as proof-of-concept for accelerating weaker domains.<br>• Positive perception of ICT's environmental impact (C1) provides a supportive foundation for strengthening Green ICT adoption. |

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| | | – renewable energy (C3d) and e-waste management (C3c). | |
| **Organisational** | • Weak departmental review and updating of initiatives (C2) – Challenge<br>• Limited awareness of policies (C4) – Challenge<br>• Insufficient resources (C5) – Challenge<br>• Weak monitoring and evaluation (C6) – Barrier<br>• Inadequate training and development opportunities (C7) – Barrier | • Establish a structured monitoring and evaluation system (C6).<br>• Increase investment in training and development programmes (C7).<br>• Improve communication strategies to raise awareness of policies (C4).<br>• Provide resources equitably across departments (C5). | • Although awareness of policies (C4) was limited, the presence of partial awareness provides a foundation that can be strengthened through improved communication and training.<br>• Departmental readiness (C2) – though weak – offers a starting point for systematic reviews. |
| **Environmental** | • Weak green standards and policies (C3h) – Challenge<br>• Partial embedding of research and innovation (C3i) – Barrier | • Strengthen departmental green standards and ensure consistent policy implementation (C3h).<br>• Institutionalise research and innovation by allocating budget and aligning it to strategic goals (C3i). | • Research and innovation practices (C3i), while partial, provide an entry point for building stronger Green ICT initiatives. |

**Source:** Author's Compilation (2025)

The following section presents the study's recommendations pertaining to secondary research objective 2.

### 6.6.3 Recommendations pertaining to the challenges and barriers that impact Organisation A's transition to Green ICT

This section presents recommendations aimed at addressing the challenges and barriers outlined in Section 6.5.3. The recommendations are organised in table form and aligned with the TOE framework to provide targeted strategies that mitigate barriers, address challenges and leverage enablers to facilitate Organisation A's transition to Green ICT.

**Table 6.3: Recommendations to address challenges and barriers affecting organisation A's transition to green ICT (Secondary Objective 2)**

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| **Technological** | • Cost of upgrading infrastructure (D13) – Barrier<br>• Need for modern technology | • Secure funding streams through phased budgeting and external financing models (D12, | • Partial sufficiency in some departments (D11) provides a base for scaling readiness. |

| | | | |
|---|---|---|---|
| | investments (D12) – Barrier<br>• Technical and infrastructure barriers (D3) – Barrier<br>• Limitations of existing ICT infrastructure (D10) – Barrier<br>• Departmental sufficiency of infrastructure (D11) – Challenge | D13).<br>• Modernise ICT infrastructure by prioritising high-risk areas (D3, D10).<br>• Standardise departmental ICT upgrade plans to improve uneven sufficiency (D11). | |
| **Organisational** | • General readiness challenges (D1) – Barrier<br>• Organisational and strategic barriers (D2) – Barrier<br>• Financial barriers (D4) and limited financial resources (D14) – Barriers<br>• Misalignment across departments (D7) – Barrier<br>• Lack of coordination (D9) – Barrier<br>• Leadership prioritisation weak (D8) – Challenge | • Integrate Green ICT into the organisational strategy with clear accountability (D1, D2).<br>• Strengthen cross-departmental alignment through governance structures and Green ICT steering committees (D7, D9).<br>• Improve budget allocation and adopt cost-sharing initiatives (D4, D14).<br>• Enhance leadership accountability by linking sustainability to performance reviews (D8). | • Existing though partial leadership prioritisation (D8) can be strengthened into a visible strategic commitment. |
| **Environmental** | • Policy and regulatory barriers (D5) – Barrier<br>• External and physical barriers (D6) – Barrier<br>• Loadshedding and operational disruptions (D16) – Barrier<br>• Geographical challenges (D17) – Barrier<br>• Partial compliance with international standards (D15) – Challenge | • Collaborate with policymakers to address regulatory gaps (D5).<br>• Implement resilience planning for external and physical barriers (D6) and loadshedding (D16).<br>• Strengthen infrastructure for remote/underserved areas (D17).<br>• Develop structured roadmaps for international compliance (D15). | • Partial compliance with standards (D15) provides a stepping-stone for aligning practices with global benchmarks. |

**Source:** Author's Compilation (2025)

The following section presents the study's recommendations pertaining to secondary research objective 3.

### 6.6.4 Recommendations pertaining to the level of employee awareness, involvement and perceptions regarding the Green ICT initiatives in Organisation A

This section provides recommendations designed to enhance employee awareness, strengthen involvement and improve perceptions of Green ICT initiatives, as discussed in Section 6.5.4. The recommendations are presented in table form and aligned with the TOE framework to outline strategies that address challenges, mitigate barriers and build on enablers to support Organisation A's adoption of Green ICT.

**Table 6.4: Recommendations to Enhance Employee Awareness, Involvement and Perceptions of Green ICT Initiatives in Organisation A (Secondary Objective 3)**

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| **Organisational** | • Limited employee involvement (E2) – Challenge<br>• Weak departmental engagement (E7) – Challenge<br>• Inconclusive communication effectiveness (E4) – Challenge<br>• Partial strategic alignment (E6) – Challenge | • Introduce participatory programmes to enhance employee involvement (E2).<br>• Establish cross-departmental Green ICT task teams to improve engagement (E7).<br>• Strengthen communication strategies through tailored awareness campaigns and digital platforms (E4).<br>• Align departmental objectives with Green ICT strategy through policy integration (E6). | • Awareness of Green ICT initiatives (E1) provides a base for improving participation.<br>• Organisational culture (E5) can be leveraged to reinforce values supportive of Green ICT.<br>• Organisational commitment (E8) can be leveraged to drive stronger alignment and cultural adoption. |
| **Environmental** | • Uncertain stakeholder engagement (E9) – Challenge | • Develop stakeholder engagement plans involving suppliers, customers and community (E9).<br>• Improve transparency and reporting of Green ICT initiatives to external parties. | • Recognition of sustainability and environmental impact (E3) provides external validation that can be scaled to engage more stakeholders. |

**Source:** Author's Compilation (2025)

The following section presents the study's recommendations pertaining to secondary research objective 4.

### 6.6.5 Recommendations pertaining to strategies for Organisation A to overcome challenges and barriers in their Green ICT implementation process

This section presents recommendations aimed at equipping Organisation A with strategies to address the challenges and barriers identified in Section 6.5.5. The recommendations are structured in table format and aligned with the TOE framework, outlining targeted actions to mitigate barriers, address persistent challenges and leverage enablers to facilitate the organisation's transition to Green ICT.

**Table 6.5: Recommendations to address challenges and barriers in Organisation A's Green ICT implementation process (Secondary Objective 4)**

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| **Technological** | • Outdated infrastructure – Barrier<br>• High cost of renewable energy adoption – Barrier<br>• Uneven energy efficiency practices – Challenge | • Invest in modern ICT infrastructure and energy-efficient systems.<br>• Secure funding for renewable energy projects through government/green financing | • Modernisation opportunities (e.g. cloud computing and AI for predictive maintenance).<br>• Renewable energy pilots already in place. |

| TOE Framework | Barriers / Challenges Identified (with Variables) | Recommendations | Potential Enablers to Leverage |
|---|---|---|---|
| | • Limited recycling initiatives – Challenge | schemes.<br>• Standardise energy efficiency practices across departments.<br>• Expand e-waste recycling programmes with measurable targets. | |
| **Organisational** | • Limited leadership prioritisation – Barrier<br>• Weak alignment across departments – Barrier<br>• Insufficient resourcing – Barrier<br>• Poor communication – Challenge<br>• Restricted employee involvement – Challenge<br>• Inadequate training – Challenge | • Formalise leadership commitment through a sustainability steering committee.<br>• Integrate Green ICT objectives into departmental KPIs for alignment.<br>• Allocate dedicated resources and budgets.<br>• Implement organisation-wide awareness campaigns and digital communication platforms.<br>• Introduce participatory employee programmes and Green ICT champions.<br>• Establish structured training and continuous development programmes. | • Strong leadership support identified by respondents.<br>• Growing organisational awareness and cultural readiness.<br>• Cross-departmental collaboration potential. |
| **Environmental** | • Loadshedding, vandalism, and theft – Barriers<br>• Regulatory uncertainty – Challenge<br>• Limited stakeholder engagement – Challenge | • Develop resilient contingency plans for power disruptions and security risks.<br>• Advocate for clearer government policy frameworks and engage in industry regulatory forums.<br>• Build stakeholder engagement programmes with suppliers, customers and communities.<br>• Strengthen compliance processes with international Green ICT standards. | • International compliance standards already being adopted.<br>• Industry partnerships and external collaborations.<br>• Community engagement opportunities. |

**Source:** Author's Compilation (2025)

The following section presents the limitations of this study.

## 6.7 LIMITATIONS OF THE STUDY

Researchers have a responsibility to acknowledge and address any technical limitations and weaknesses that arise during a study (Babbie, 2016). Limitations are regarded as potential weaknesses that lie beyond the researcher's control, often stemming from factors such as research design, statistical models, funding constraints or organisational circumstances; and

must be acknowledged to ensure a comprehensive understanding of the research scope and implications (Theofanidis & Fountouki, 2018).

This study was subject to the following limitations:

- **Restricted respondent group**: The survey was administered only to employees within the technology division of Organisation A. This focus excluded staff from other divisions of the organisation, whose perspectives may also influence Green ICT adoption. Technology employees were specifically targeted as they are most directly involved in ICT network infrastructure, operations and implementation processes; making them best positioned to provide relevant insights. While this focus provided depth and relevance, it also means the findings may not fully capture organisation-wide readiness and adoption dynamics.
- **Cross-sectional design**: The study adopted a cross-sectional design, meaning that data was collected at a single point in time. This limits the ability to track changes in awareness, readiness or adoption over time.
- **Self-reported data**: Data were collected through an online survey (Lime Survey), relying on employees' perceptions. As with all self-reported data, there is a risk of response bias, where respondents may overstate positive practices or understate challenges.
- **Participation bias:** While the sample size of 205 responses was adequate and all departments were represented, participation levels varied across departments. This uneven distribution may have influenced the balance of perspectives reflected in the findings, with some departments contributing more extensively than others.
- **Limited qualitative depth:** Although the study employed a qualitative approach, the inclusion of only a single open-ended question restricted the richness of contextual insights. A broader range of qualitative methods (e.g. interviews or focus groups) might have provided deeper explanations for why certain challenges and barriers persist.

To mitigate these limitations, several steps were taken during the research process. Targeting technology employees ensured that respondents with the most direct expertise in ICT network infrastructure and operations were surveyed; providing depth and relevance to the findings even if perspectives from other divisions were excluded. While the cross-sectional design limited longitudinal insights, the survey was carefully timed to capture a representative snapshot during a critical stage in Organisation A's transition to Green ICT. To reduce potential

response bias, the questionnaire was designed with neutral wording and pre-tested to ensure clarity and ease of understanding. Non-response was addressed through reminders and follow-ups, resulting in 205 completed responses that provided a sufficiently rich dataset for analysis. Finally, although qualitative input was restricted to a single open-ended question, it allowed respondents to suggest strategies in their own words, which complemented the structured items with valuable contextual insights. The following section presents the delimitations of this study

## 6.8 DELIMITATIONS OF THE STUDY

The study was delimited to Organisation A, a South African telecommunications company, to enable an in-depth examination of its transition to Green ICT. Data collection was restricted to employees within the technology division, as they are directly engaged in ICT network infrastructure, planning, operations and implementation. Consequently, employees from non-technology divisions were excluded. As a result, the findings cannot be generalised to the entire organisation or to other telecommunications companies in SA. The following section outlines this study's contribution to the body of knowledge.

## 6.9 CONTRIBUTION TO THE BODY OF KNOWLEDGE

This study contributes to the academic discourse on GICT adoption by providing empirical evidence from the South African telecommunications sector, a context where literature remains limited. The conclusions presented in Chapter 6, (§6.5.1, primary research objective), (§6.5.2, secondary objective 1), (§6.5.3, secondary objective 2), (§6.5.4, secondary objective 3) and (§6.5.5, secondary objective 4) establish this study's overall contribution to knowledge by addressing barriers, challenges and readiness factors that influence adoption across the technological, organisational and environmental frameworks. As a result, and in line with the empirical analyses presented in Chapter 5 (§5.5–§5.10), this research fills a sector-specific gap in GICT literature and provides a reference point for future studies in telecommunications sustainability.

### 6.9.1 Common findings with global literature

The study confirmed several patterns that align with international research on GICT adoption:

- **Cultural and organisational barriers:** Cultural resistance, entrenched norms and limited awareness were evident in Organisation A (§6.5.1; §6.5.3), consistent with prior findings from the Netherlands and Brazil that emphasise the difficulty of shifting behaviours and organisational culture to support sustainability (§2.4.3).
- **Knowledge and communication challenges:** Organisation A demonstrated gaps in knowledge-sharing, training and effective communication of Green ICT initiatives (§6.5.1; §6.5.3; §6.5.4). Similar knowledge and communication deficits have been documented in the Netherlands, Brazil and Bangladesh, where inadequate expertise and poor dissemination hinder adoption (§2.4.3).
- **Policy and regulatory barriers:** Uncertainty in regulatory frameworks and partial compliance with standards were identified as barriers in Organisation A (§6.5.3), echoing global studies from Asia, India and Romania that highlight regulatory inefficiencies and weak enforcement as obstacles to adoption (§2.4.3).
- **Technical and infrastructure barriers:** Organisation A faced outdated infrastructure, uneven readiness, and high costs of renewable integration (§6.5.1; §6.5.3). These mirror international evidence from Albania, Nepal and Bangladesh, where insufficient infrastructure and technological limitations are recurring barriers to adoption (§2.4.3).
- **External and physical barriers**: External pressures such as loadshedding, theft, vandalism and geographical constraints were identified as significant barriers in Organisation A (§6.5.3). These findings are consistent with global studies that report similar challenges, including geographical difficulties in Nepal, security risks in South Asia and inefficiencies in recycled material supply chains across Europe (§2.4.3).
- **Financial barriers:** High costs of implementation and limited funding were consistently identified as barriers within Organisation A (§6.5.1; §6.5.3), mirroring global studies from Asia, Bangladesh and Romania that emphasise the financial challenges of transitioning to Green ICT (§2.4.3).

By demonstrating that these global challenges and barriers are equally relevant within Organisation A, this study strengthens the international evidence base and validates the applicability of the GITAM and TOE frameworks to the South African telecommunications sector.

### 6.9.2 New contributions of this study

Beyond validating global patterns, the research provides new context-specific insights that extend the literature:

- **Sector-specific empirical evidence:** This study contributes by providing focused empirical insights from within a major telecommunications operator (§6.5).
- **Loadshedding as a contextual barrier:** While reliance on fossil-based backup power is recognised globally, in SA the intensity and frequency of loadshedding exacerbates this dependence, making it a particularly acute and context-specific barrier to sustainability (§6.5.3).
- **Security and physical constraints:** Theft and space limitations emerged as critical barriers to renewable energy deployment, factors not widely documented in global GICT research (§6.5.3).
- **Employee perceptions and readiness:** By assessing awareness and attitudes among employees, the study provides contextual insights into organisational culture that complement existing global literature (§6.5.4).
- **Telecommunications-focused recommendations:** This study extends existing GICT research by offering recommendations specifically tailored to the telecommunications industry in SA, balancing digital expansion with sustainability imperatives (§6.6).

### 6.9.3 Closing the literature gap

The contribution of this study lies in two interrelated areas:

- It reinforces global findings by validating key drivers, challenges and barriers to Green ICT adoption in the South African telecommunications sector (§6.5).
- It introduces novel, contextually grounded insights such as the role of loadshedding, theft and employee perceptions, thereby enriching the literature and offering practical guidance for policymakers, practitioners and industry leaders in SA and similar developing country contexts (§6.5–§6.6).

Together, these contributions extend the theoretical and empirical understanding of GICT adoption by situating global insights within the unique realities of SA, while addressing the

limited academic focus on this sector. The following section discusses the management implications.

## 6.10 MANAGEMENT IMPLICATIONS

The findings of this study carry significant implications for managers within Organisation A as well as the wider South African telecommunications sector. By focusing on the barriers, challenges and enablers that directly influence managerial decision-making, the study provides actionable insights for strengthening Green ICT adoption.

- **Organisational and strategic implications**

Managers must recognise readiness challenges (D1) and organisational and strategic barriers (D2) as critical obstacles that limit coordinated adoption. These require deliberate action through improved strategic alignment, resource allocation and long-term planning. Leadership support (B6) and organisational commitment (E8) were confirmed as key enablers; managers should formalise this support through visible initiatives such as Green ICT steering committees and cross-departmental taskforces.

- **Communication and knowledge implications**

Knowledge and communication gaps (B2, B7, C4) as well as inconclusive communication effectiveness (E4) highlight weaknesses in information sharing and awareness. Managers need to implement clear, consistent communication strategies, using both traditional and digital platforms to ensure employees understand the importance of Green ICT. Strengthening departmental reviews (C2) and monitoring and evaluation systems (C6) will allow managers to track progress and adjust strategies accordingly.

- **Training and capacity-building implications**

Limited training opportunities (B9, C7) emerged as major barriers. Managers must prioritise the design and rollout of comprehensive training and development frameworks that embed Green ICT skills into daily practice. Such initiatives can improve employee readiness and reduce resistance to change, particularly where reluctance (B4) still persists.

- **Alignment and participation implications**

Managers need to address partial strategic alignment (E6) and weak departmental engagement (E7) by integrating Green ICT goals into departmental objectives and performance measures. Enhancing employee involvement (E2) through participatory programmes and incentives can further drive adoption, while stakeholder engagement (E9) must be strengthened through transparent reporting and inclusive collaboration with suppliers, regulators and customers.

Collectively, the findings imply that managers must adopt a holistic approach to overcoming organisational readiness gaps, strategic misalignment and weak communication systems. By leveraging enablers such as leadership support (B6), organisational awareness (E1) and customer expectations (B10), managers can build momentum towards sustainable ICT adoption. These actions will not only improve internal effectiveness but also position Organisation A as a leader in advancing national and global sustainability goals. The next section highlights the future research studies.

## 6.11 FUTURE RESEARCH STUDIES

As a result of the problem statement articulated in Chapter 1 (§1.5), and attained in Chapter 5 (§5.4 – research problem revisited), the research questions outlined in Chapter 1 (§1.6) were informed by the data analysis and conclusions presented in Chapter 5 (§5.11) and explicitly answered in Chapter 6 (§6.5–§6.12). The study presented insights into the evaluation of the barriers, challenges and readiness factors influencing Green ICT adoption within Organisation A. Moreover, as a result of the research objectives outlined in Chapter 1 (§1.7), achieved in Chapter 5 (§5.5–5.9 – analysis of Sections B–E) and concluded in Chapter 6 (§6.5.1–6.5.5), the study identified and evaluated the technological, organisational and environmental factors impacting Green ICT adoption in the South African telecommunications context.

Therefore, the possible future research areas that emanate from this study include the following:

- The study was limited to employees in the technology division of Organisation A. Future research could expand to include other divisions such as customer operations, supply chain or corporate strategy to capture a broader organisational perspective.
- The study was conducted in a single telecommunications company. Future studies could be extended to other South African telecommunications providers, or across

multiple organisations in the ICT sector, to allow for comparative analysis and broader generalisability.

- This study primarily relied on quantitative analysis using a survey instrument. Future research could incorporate qualitative approaches such as case studies, interviews and focus groups to provide deeper contextual understanding of adoption challenges and barriers.
- As this study adopted a cross-sectional time horizon, it provided a snapshot of adoption at a specific point in time. Future studies could adopt a longitudinal approach to track changes in readiness, awareness and adoption over time.
- Future research could also examine the role of external stakeholders, such as government regulators, industry partners and communities, in shaping Green ICT adoption and the strategies needed for stronger collaboration. The next section outlines the conclusion.

## 6.12 CONCLUSION

Chapter 6 presented the overall conclusions of the study, supported by a synopsis of the research, a restatement of the research problem, a summary of the main findings and conclusions aligned with the primary and secondary objectives. It further included recommendations to strengthen GICT adoption, the study's limitations and delimitations, contributions to knowledge, managerial implications and directions for future research.

The study set out to investigate the challenges facing a South African telecommunications organisation in transitioning to GICT. Guided by the GITAM framework, with the TOE frameworks providing the organising lens, the research examined barriers, challenges, enablers and readiness factors across technological, organisational and environmental domains. Employee awareness, involvement and perceptions were also assessed, while strategies to enhance adoption were identified.

The research problem, framed in Chapter 1 (§1.2), highlighted the dual challenge of sustaining digital expansion while mitigating the environmental pressures of ICT operations in SA. This problem was addressed through the research objectives and questions. The primary objective of identifying the main challenges to GICT adoption was achieved by showing how financial constraints, infrastructural gaps, cultural resistance and limited training obstruct readiness;

while respondents indicated that leadership support and customer expectations could serve as potential enabling factors (§6.5.1). The secondary objectives were likewise achieved. The current state of adoption was found to be uneven, with progress evident in virtualisation, remote work and network efficiency, but significant gaps in areas such as e-waste management, renewable energy integration and training identified (§6.5.2). Readiness was constrained by financial barriers, misalignment across departments and external risks including loadshedding and geographical limitations (§6.5.3). Employee-related findings revealed that awareness and organisational commitment served as enablers, while weak involvement, engagement and communication undermined effectiveness (§6.5.4). Finally, practical strategies were identified to address these barriers and challenges, with emphasis on leadership commitment, investment in infrastructure, training and collaborative stakeholder engagement (§6.5.5).

This study contributes academically by validating global findings on financial, regulatory and cultural drivers and barriers (§2.4.2–§2.4.3; §5.5–§5.8); while extending knowledge by identifying contextual factors unique to SA such as loadshedding, theft and infrastructural constraints (§5.7–§5.8). It also advances practice by offering recommendations tailored to the telecommunications sector, addressing the balance between digital growth and sustainability (§6.6). In conclusion, the research problem has been addressed, as the study provides a comprehensive understanding of the barriers, challenges and enablers shaping Green ICT adoption in Organisation A. It fills a gap in the academic literature on GICT in the South African telecommunications sector, while also providing actionable insights for managers, policymakers and practitioners seeking to advance sustainability in ICT.

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# ANNEXURE A: ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

College of Economic and Management Sciences_CRERC

Ref #: 5565
Name: Mr Sivapragasen Naidoo
Student #: 40510859

Date: 05/12/2024

Dear: Mr Sivapragasen Naidoo

**Decision: Ethics Approval from 05 December 2024 to 04 December 2027**

---

**Researcher:** Mr Sivapragasen Naidoo

Vodacom Campus Rd, Noordwyk, Midrand, 1687

Johannesburg

40510859@mylife.unisa.ac.za 0825752394

**Supervisor:** Professor Prof BARNES Sookdeo bsookdeo@unisa.ac.za

**Challenges in transitioning to green ICT in a South African telecommunication company**

**Qualification:** Master of Commerce in Business Management

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Thank you for the application for research ethics clearance by the College of Economic and Management Sciences_CRERC for the above mentioned research study. Ethics approval is granted for three years.

The **low risk application** was **reviewed** by College of Economic and Management Sciences_CRERC on 18 November 2024 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Economic and Management Sciences_CRERC.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.

---

5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.

7. No field work activities may continue after the expiry date (04 December 2027). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

**Additional Conditions**

1. Disclosure of data to third parties is prohibited without explicit consent from Unisa.
2. De-identified data must be safely stored on password protected PCs.
3. Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
4. Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.

Note

The reference number 5565 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,

Prof V Sambo
Chair of College of Economic and Management Sciences_CRERC
E-mail: esambovt@unisa.ac.za

Prof MC Mulaudzi
Executive Dean / By delegation from the Executive Dean of College of Economic and Management Sciences_CRERC
E-mail: tshilmc@unisa.ac.za, mosalgk@unisa.ac.za

## ANNEXURE B: GATEKEEPER RESEARCH PERMISSION APPLICATION FORM



UNISA university of south africa

### GATEKEEPER RESEARCH PERMISSION APPLICATION FORM

**A. GATEKEEPER CONTACT INFORMATION**

**TO:**

**Name of organisation/company/stakeholder/community leader – referred to as the 'gatekeeper':**

Vodacom SA

**Contact person (name and surname):**

David Mtsweni

**Designation/position within company/organisation/community:**

Executive Head of Department of Operations in Southern Gauteng

**Email:**

David.Mtsweni@Vodacom.co.za

**Contact number:**

0829909671

**B. APPLICANT INFORMATION**

**FROM:**

Name and surname of applicant/student/researcher:

Sivapragasen Naidoo

Degree registered for or research for non-degree purposes:

MCOM

Department and College:

Operations Management, CEMS

Email:

40510859@mylife.unisa.ac.za

Contact number:

0825752394

Address:

3 Dolomiet Avenue, Zwartkop, Centurion, Pretoria, 0051

Details of supervisor (if applicable):

Professor Barnes Sookdeo

Email of supervisor (if applicable):

BSookdeo@unisa.ac.za

Supervisor's position, e.g. lecturer/senior lecturer/professor, etc.:

Professor

Supervisor's Department:

Operations Management

Funding Body (if applicable):

UNISA Bursary

Reason for funding (if applicable):

MASTERS & DOCTORAL funding, finished with Cum Laude in BCOM Honours

## C. REQUEST FOR SUPPORT/ ACCESS TO DATA/INFORMATION/ PARTICPANTS

I/We are requesting your assistance in a study entitled:

Challenges in transitioning to green ICT in a South African telecommunication company

Overview of study: (100-200 words)

- What, how and why of the study
- Objectives, time and resources used/required
- Deadline/timelines for the project – possibility of follow up interviews? If further information will be required

This study analyses the challenges faced by the telecommunications sector in transitioning to green ICT, driven by the sector's rapid growth and increasing data demand. The expansion of telecommunication networks presents significant hurdles for network operators, including managing energy needs, limited fuel resources, and addressing global warming concerns as more equipment is deployed globally. Motivated by the urgent need for sustainability, this research highlights the barriers telecommunications organisations in South Africa face in adopting green ICT practices. The transition to green technology is essential to tackle environmental issues, reduce carbon dioxide emissions, and achieve sustainability goals, particularly in alignment with SDGs 7, 9, 11, 12, and 13.The knowledge gained could be utilised in guiding organisational and governmental bodies' strategic decision-making and policy formulation to advance sustainability in this industry and assist Organisation A's plan for green ICT. This study's importance lies in its contribution to the body of knowledge on green ICT and its practical application in meeting environmental and operational goals.

The primary objective of this study is to identify the main challenges that a South African telecommunications organisation faces when transitioning to green ICT. The secondary objectives are: 1 To evaluate the current state of green ICT adoption within Organisation A.2 To investigate the challenges and barriers that affect Organisation A's transition to green ICT.3To determine the level of employee awareness, involvement, and perceptions regarding the green ICT initiatives in Organisation A.4 To provide recommendations on strategies for Organisation A to overcome challenges and barriers in their green ICT implementation process.

The project is expected to take approximately one year to complete, encompassing phases of data collection, analysis, interpretation, and the formulation of recommendations. Follow-up interviews may be conducted if additional insights are required. The project timeline will align with academic schedules, including deadlines for ethical approval and research submission. The resources needed include access to employee participation for the survey. All data pertaining to the organisation has been sourced from publicly available information, such as integrated reports, financial statements, and the Task Force on Climate-related Disclosures (TCFD) report.

My/our request is/are for: (Tick appropriate options and/or add additional information.)

- ☐ Permission and/or support to conduct a study about or within the organisation/company/stakeholder group/community
- ☐ Access to possible participants and assistance for recruitment and identification purposes
- ☐ Assistance in the recruitment process of possible participants via internal communication
- ☑ Permission to distribute questionnaire/survey/research information to potential participants
- ☐ Access to organisational data – not in the public domain
- ☐ Other (specify below):

Provide a full description of the intended research sample. Motivate why the data must be gathered from the specific stakeholder group/organisation/company/community.

The intended research sample for this study will consist of employees from the technology group in the Organisation A. This includes operational employees in the regional departments, who have a dotted reporting line to the central technology department. In this study, the objective is to examine the collective perceptions of ICT professionals and senior-level managers involved in ICT processes at Organisation A to investigate the challenges of transitioning to green ICT. The determined sample size for this study is 297 actively involved ICT professionals and senior-level managers within Organisation A.

The focus on this specific group is motivated by their direct involvement in ICT operations, making them key stakeholders in the adoption and implementation of green ICT practices. These employees possess critical experience and knowledge related to the organisation’s ICT infrastructure, sustainability initiatives, and the challenges associated with transitioning to greener technologies. Their insights are crucial for understanding both the operational and strategic barriers to green ICT adoption.

By gathering data from this group, the study aims to gain a comprehensive view of the practical challenges and enablers within the organisation, thus ensuring that the research reflects the realities faced by those directly engaged with ICT and sustainability initiatives. Their feedback will also be instrumental in providing recommendations to overcome the challenges identified and improve the organisation's green ICT strategies.

Explain how the participant identification and recruitment process of your research adhere to the Protection of Personal Information Act 4 of 2013.

The participant identification and recruitment process for this research will strictly follow the Protection of Personal Information Act 4 of 2013 (POPIA) to ensure privacy, confidentiality, and security of personal data. No identifiable information, such as names, will be collected, and all responses will be anonymised. A confidentiality agreement will be signed by the statistician. Participation is voluntary, with informed consent obtained from all participants and organisation management. Data collection will be limited to relevant information, and no personal contact details will be gathered. Data will be securely stored, either in a locked environment or password-protected files, and only used for this study's purposes.

The researcher will follow UNISA's Research Ethics Policy, seek ethical clearance from the university's ethics committee, and ensure compliance with all ethical standards. These measures align with POPIA to safeguard participants' privacy and data.

Provide a description of the data collection tools (e.g. interview, questionnaire, questions).

The primary data collection tool for this study is a questionnaire, which includes both structured questions and an open-ended question. The structured questions are designed to collect quantifiable data using a 5-point Likert scale, where participants will rate statements regarding the challenges and barriers of transitioning to green ICT. These questions aim to assess employee perceptions, organisational readiness, and the effectiveness of green ICT practices. The open-ended question allows participants to provide additional insights and recommendations related to strategies for overcoming the identified challenges and barriers.

6

Provide a description of the data gathering process that will be followed. (What will be expected of the research participants and exactly how will the data be collected?)

The data collection process will involve distributing the questionnaire to employees within Organisation A's technology department, including technical staff in regional departments, and utilising the reliable online survey platform, Lime Survey. Participants will receive an email invitation containing a link to the online questionnaire, along with detailed instructions on how to complete it. They will be informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality measures in place to protect their responses.

Participants will be asked to provide their opinions on various statements about green ICT practices, challenges, and barriers using the Likert scale. They will also be expected to answer one open-ended question to suggest strategies for overcoming the barriers identified in the transition to green ICT. The estimated time for completion is 15-20 minutes.

Indicate who will have access to the raw data and in what formats?

Access to the raw data will be limited to the researcher, the research supervisor, and the statistician.The researcher will access the raw data for analysis, while the supervisor oversees it. The statistician will use the data for analysis under a confidentiality agreement. The raw data for this study will be in both electronic and spreadsheet formats, such as CSV (Comma-Separated Values) or Excel files, which are suitable for statistical analysis. The formats are compatible with data analysis tools, ensuring efficient processing by the researcher and statistician.

Provide a full description of the perceived and actual risks of the study to participants and the organisation/company/stakeholder group/community. (Keeping national disasters in mind.)

The research poses minimal risks to both the participants and the organisation. No physical or emotional harm will come to the participants as the study only involves answering structured and open-ended questions about green ICT initiatives. The questionnaire is designed to be non-intrusive, and participants will remain anonymous, ensuring that no sensitive or personally identifiable information is collected. Furthermore, participants will have the opportunity to withdraw from the study at any stage without penalty.

To safeguard the organisation, all collected data will be anonymised, and only aggregated results will be reported. This ensures that no individual participant or specific department within Organisation A can be identified. There are no financial or reputational risks involved for Organisation A, as the findings will focus on constructive recommendations for improvement in green ICT practices rather than any critique of existing operations.

7

Describe the potential benefits of the study to the organisation/company/stakeholder group/community.

The potential benefits of the study for Organisation A are substantial. The research will provide valuable insights into the challenges and barriers the organisation faces in its transition to green ICT, enabling the development of more effective strategies to overcome these obstacles. This could lead to improved energy efficiency, reduced operational costs, and enhanced environmental sustainability within the organisation.

Additionally, the findings will support Organisation A in aligning its sustainability initiatives with broader environmental goals. By implementing the recommended solutions, Organisation A can enhance its long-term sustainability, improve its competitive position in the telecommunications industry, and bolster its reputation for responsible environmental practices. The knowledge gained from this study will be instrumental in guiding the organisation's future ICT strategies, helping it to meet both operational and environmental objectives.

How will risks be mitigated and managed? (Keeping national disasters and relevant protocol in mind.)

Given that the research involves online data collection, there are minimal physical risks to participants. However, data security is a top priority, and all personal information will be handled with strict confidentiality. This will be achieved by employing password-protected digital files, secure online survey platforms, and an encrypted digital storage device locked in a physical space to prevent unauthorised access to the data.

In terms of potential disruptions caused by national disasters, the online nature of the research ensures flexibility. Participants can complete the questionnaire at their convenience, and if unforeseen events such as natural disasters or national emergencies occur, the research timeline can be adjusted to accommodate those impacted. This flexibility ensures that participants' safety and well-being are prioritised. To manage risks, disaster protocols will be followed if necessary, including pausing data collection or extending deadlines to address participants' needs. Participation is voluntary, and individuals can withdraw at any time without consequences. Flexible timing allows participants to engage at their convenience, reducing any potential

Explain the extent and processes to which confidentiality of information will be maintained by the researcher.

To ensure confidentiality, the study will omit participant names and identifying information from questionnaires. Respondents will be instructed not to disclose any personal identifiers. All collected data will be securely stored in a password-protected digital environment and an encrypted digital storage device locked in a physical space. The data will be preserved for a period of five years. A confidentiality agreement will be signed by the statistician to safeguard the information. Furthermore, respondents will be assured that their identities will not be linked to their responses, promoting honest participation. They will also be informed that their responses will be treated with strict confidentiality throughout the research process.

8

List the expected deliverables of the study. (For example, a research report, journal articles and/or conference proceedings. Also indicate how privacy will be protected in any publication of the information.)

The expected deliverables of the study include a dissertation and may include a publication in an academic journal article. In both the dissertation and any publications, the privacy and confidentiality of the organisation and participants will be strictly maintained. The name of Organisation A will not be disclosed, and no personal identifiers will be included.

How will the organisation/company/stakeholder group/community be informed of the results or outcomes? (If applicable.)

Upon completion of the study, the findings will be shared with Organisation A by providing the dissertation, ensuring that the results are communicated clearly and effectively. A summary of key outcomes will be presented to the organisation's management, highlighting insights relevant to green ICT practices and the challenges encountered during the transition process. Organisation A will also have access to the final dissertation, with any additional information available upon request. The organisation's name will remain confidential throughout the dissemination process.

**Attach a copy of the research instrument (questionnaire/interview schedule/focus group questions) to your email and mark as Annexure A**

## C. OFFICIAL USE ONLY – TO BE COMPLETED BY COMPANY/ORGANISATION/COMMUNITY

**Decision:**

☑ Permission granted.
☐ Permission with conditions is granted.
☐ No permission could be granted at this time.

**Special Conditions** (if any – Expectations of the outcomes of the study must be stated. For example: Will feedback/a report be required before submission of the publication?):

A preliminary report is required before final publication

The following person and/or department/and or committee has been appointed to assist the researcher in the data collection process (if applicable):

N/A

By signing this form, you are indicating that you have read the description of the study, **have the legal and delegated authority to grant permission for the study on behalf of the company/organisation/stakeholder/community** and that the company/organisation/stakeholder/community in principle agrees to the terms as described in the short questionnaire that follows:

1. **I/We have reviewed the application form and received a copy of it. The purpose and nature of this study are clear, and all questions and issues of concern have been answered to satisfaction.**

☑ **Yes**
☐ **No**

2. **I/We (name of the person responsible and/or name of company/organisation/stakeholder/community)**

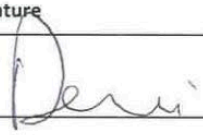
David Mtsweni

**agree to support this study and hereby grant permission for the data generated from this research to be used in the researcher's publications on this topic.**

☑ **Yes**

☐ **No**

**Signature**



**Name and surname of the person with delegated authority to grant permission on behalf of the company/organisation/stakeholder/community**

David Mtsweni

**Designation/Position**

Executive Head of Department Operations SG region

**Email:**

David.Mtsweni@vodacom.co.za

**Contact number:**

0829909671

**Date:**

2024/10/07

**Official stamp (if available):**

# ANNEXURE C: PERMISSION LETTER

Docusign Envelope ID: 7CE8CDF8-CC32-4FBE-9963-F96557A36D4B

| | |
|---|---|
| **TO:** | **Mr Sivapragasen Naidoo** |
| **CC:** | **Sarah Mthintso**<br>Executive Head of Department (EHOD): Public Affairs, Vodacom SA |
| **From:** | **Sandi Nwendamutswu**<br>Principal Specialist: Public Affairs |
| **Date:** | 03 October 2024 |
| **Subject:** | Letter of permission to investigate the "***Challenges in transitioning to green ICT in a South African telecommunication company"*** towards MCOM degree with the University of South Africa (UNISA). |

Dear Mr Naidoo,

This letter serves to confirm that Vodacom permits you to conduct research on the "***Challenges in transitioning to green ICT in a South African telecommunication company"*** towards your MCOM with the University of South Africa (UNISA). Please note that the approval does not guarantee participation of Vodacom employees in the programme, as it is voluntary.

Vodacom permits you to conduct the research on the following conditions:

- All information gathered during interviews or surveys will only be used for academic purposes relating to your MCOM with the University of South Africa (UNISA).
- All information accessed and shared is not categorised as ***"company confidential"***.
- No information acquired from Vodacom or its employees will be used in another academic programme or case study, without prior consent by Vodacom.
- No information will be shared in any public platform, except in an academic journal or platform only as it relates to the aforementioned programme.

Furthermore, if your dissertation/thesis/research report will be published in the public domain, Vodacom therefore request that you provide a preliminary report before final publication to ensure that the report does not contain outcomes which are commercial in nature. During the interviews or survey, the respondents ***are not allowed to provide you with information that is classified as confidential at Vodacom and not for public use.*** This letter is not an official endorsement of the content or findings of the research, views and opinions expressed during interviews or collected through surveys do not represent the position of Vodacom on any issue probed.

Should you have any questions, kindly contact Ms. Sandi Nwendamutswu on mobile: +27 66 4743030 or by email on sandi.nwendamutswu@vodacom.co.za

Sincerely yours,

Signed by:
sandi nwendamutswu
99685E52725D4BC...

**Sandi Nwendamutswu**
Principal Specialist: Public Affairs,

## ANNEXURE D: COVER LETTER TO AN ONLINE ANONYMOUS WED-BASE SURVEY, PARTICIPANT INFORMATION AND CONSENT

**Ethical clearance Ref #: 5565**

**COVER LETTER TO AN ONLINE ANONYMOUS WEB-BASED SURVEY**

Dear Prospective Participant,

You are invited to participate in a survey conducted by Sivapragasen Naidoo under the supervision of Barnes Sookdeo, a professor, in the Department of Operations Management towards a Master of Commerce in Business Management at the University of South Africa.

The survey you have received has been designed to study the challenges associated with transitioning to green ICT within a telecommunications organisation in South Africa. Green ICT refers to the environmentally sustainable management, use, design, and disposal of Information and Communication Technology (ICT), which encompasses technologies like computers, networks, and telecommunications systems. It aims to reduce energy consumption, minimise waste, and mitigate environmental impacts while enhancing sustainability efforts.

You were selected to participate in this survey because you are part of the technology employee group actively involved in ICT processes at Organisation A. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

It is anticipated that the information we gain from this survey will help us to identify and address the primary challenges and barriers to transitioning to green ICT in Organisation A. You are, however, under no obligation to complete the survey, and you can withdraw from the study prior to submitting the survey. The survey is developed to be anonymous, meaning that we will have no way of connecting the information that you provide to you personally. Consequently, you will not be able to withdraw from the study once you have clicked the send button based on the anonymous nature of the survey. If you choose to participate in this survey, it will take up no more than 20 minutes of your time. You will not benefit from your participation as an individual; however, it is envisioned that the findings of this study will help Organisation A and the broader telecommunications sector to transition more smoothly to green ICT and achieve their sustainability goals. We do not foresee that you will experience any negative consequences by completing the survey. The researcher undertakes to keep any information provided herein

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

confidential, not to let it out of our possession, and to report on the findings from the perspective of the participating group and not from the perspective of an individual.

The records will be kept for a minimum period of five years for audit purposes, after which they will be permanently destroyed. Hard copies will be shredded, and electronic versions will be permanently deleted from the hard drive of the computer. De-identified research data could be stored indefinitely to allow for data sharing or future use in studies with similar aims and objectives. You will not be reimbursed or receive any incentives for your participation in the survey.

The research was reviewed and approved by the Research Ethics Review Committee of the College of Economic and Management Science (CEMS), College Research Ethics Review Committee (CRERC). The primary researcher, Sivapragasen Naidoo, can be contacted during office hours at 0825752394 and 40510859@mylife.unisa.ac.za. The study leader, Professor Barnes Sookdeo, can be contacted during office hours at 012 429 2474 and bsookdeo@unisa.ac.za. Should you have any questions regarding the ethical aspects of the study, you can contact the research ethics chairperson of the College of Economic and Management Science (CEMS), Operations Management, Professor Sumei van Antwerpen, during office hours at 0124294988 and vanans@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the university's Toll-Free Hotline 0800 86 96 93.

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Change language English - English

# Welcome title

**Survey on green ICT Challenges**
Welcome to our survey on the challenges and opportunities in transitioning to green ICT within the South African telecommunication industry. Your participation is invaluable in helping us understand the obstacles faced during this transition and in developing actionable insights for improvement. The survey will take approximately **15 minutes** to complete. All responses are anonymous and will be used solely for research purposes.
Please click Next to proceed.

Start survey or press ↵

Dear Prospective participant,
You are invited to participate in a survey conducted by Sivapragasen Naidoo under the supervision of Barnes Sookdeo, a professor, in the Department of Operations Management towards a Master of Commerce in Business Management at the University of South Africa.
The survey you have received has been designed to study the challenges associated with transitioning to green ICT within a telecommunications organisation in South Africa. Green ICT refers to the environmentally sustainable management, use, design, and disposal of Information and Communication Technology (ICT), which encompasses technologies like computers, networks, and telecommunications systems. It aims to reduce energy consumption, minimise waste, and mitigate environmental impacts while enhancing sustainability efforts.
You were selected to participate in this survey because you are part of the technology employee group actively involved in ICT processes at Organisation A. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.
It is anticipated that the information we gain from this survey will help us to identify and address the primary challenges and barriers to transitioning to green ICT in Organisation A. You are, however, under no obligation to complete the survey, and you can withdraw from the study prior to submitting the survey. The survey is developed to be anonymous, meaning that we will have no way of connecting the information that you provide to you personally. Consequently, you will not be able to withdraw from the study once you have clicked the send button based on the anonymous nature of the survey. If you choose to participate in this survey, it will take up no more than 15 minutes of your time. You will not benefit from your participation as an individual; however, it is envisioned that the findings of this study will help Organisation A and the broader telecommunications sector to transition more smoothly to green ICT and achieve their sustainability goals. We do not foresee that you will experience any negative consequences by completing the survey. The researcher undertakes to keep any information provided herein confidential, not to let it out of our possession, and to report on the findings from the perspective of the participating group and not from the perspective of an individual. The records will be kept for a minimum period of five years for audit purposes, after which they will be permanently destroyed. Hard copies will be shredded, and electronic versions will be permanently deleted from the hard drive of the computer. De-identified research data could be stored indefinitely to allow for data sharing or future use in studies with similar aims and objectives. You will not be reimbursed or receive any incentives for your participation in the survey.
The research was reviewed and approved by the Research Ethics Review Committee of the College of Economic and Management Science (CEMS), College Research Ethics Review Committee (CRERC). The primary researcher, Sivapragasen Naidoo, can be contacted during office hours at 0825752394 and 40510859@mylife.unisa.ac.za. The study leader, Professor Barnes Sookdeo, can be contacted during office hours at 012 429 2474 and bsookdeo@unisa.ac.za. Should you have any questions regarding the ethical aspects of the study, you can contact the research ethics chairperson of the College of Economic and Management Science (CEMS), Operations Management, Professor Sumei van Antwerpen, during office hours at 0124294988 and vanans@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the university's Toll-Free Hotline 0800 86 96 93.

1→ *

You are making a decision about whether or not to participate by continuing to the next page. You are free to withdraw from the study at any time prior to clicking the "I agree" button. Please confirm your participation in the study by selecting "I agree" By participating, you acknowledge that you have read the information provided and agree to take part in this research.

◯ I agree

◯ I disagree

# ANNEXURE E: RESEARCH QUESTIONNAIRE

**SECTION A: Demographics and Background Information**

**INSTRUCTIONS:** Kindly complete the demographic information below. Please note that all personal information will be treated with the utmost confidentiality, and none of your responses will be associated with your name, email address, or any other identifiable details.

This section aims to gather demographic and background details about participants in order to provide context and support the analysis of the responses in relation to the adoption of green ICT practices within Organisation A.

**Green ICT Definition:** Green ICT refers to the environmentally sustainable management, use, design, and disposal of Information and Communication Technology (ICT), which encompasses technologies like computers, networks, and telecommunications systems. It aims to reduce energy consumption, minimise waste, and mitigate environmental impacts while enhancing sustainability efforts.

Please indicate your response by placing a tick (√) in the appropriate box.

**1. Please state your gender.**

| No. | Gender | Tick |
|---|---|---|
| 1.1 | Male | |
| 1.2 | Female | |
| 1.3 | Not specified | |

**2. Please state your age.**

| No. | Age | Tick |
|---|---|---|
| 2.1 | 18 - 25 years | |
| 2.2 | 26 – 35 years | |
| 2.3 | 36 – 45 years | |
| 2.4 | 46 – 55 years | |
| 2.5 | 56 – 65 years | |

**3. State your position in the organisation.**

| No. | Position in the organisation | Tick |
|---|---|---|
| 4.1 | Technical Assistance | |
| 4.2 | Technical Officer | |
| 4.3 | Senior Technical Officer | |
| 4.4 | Specialist | |
| 4.5 | Senior Specialist | |
| 4.6 | Manager | |
| 4.7 | Executive Head of Department | |

| | | |
|---|---|---|
| 4.8 | Managing Executive | |
| 4.9 | Technology Director | |

**4. State how many years have you been working in the organisation.**

| No. | Years of experience | Tick |
|---|---|---|
| 5.1 | 1 to 2 years | |
| 5.2 | 3 to 5 years | |
| 5.3 | 6 to 10 years | |
| 5.4 | 11 to 15 years | |
| 5.5 | 16 to 20 years | |
| 4.6 | More than 20 years | |

**5. State which department do you work in.**

| No. | Department | Tick |
|---|---|---|
| 6.1 | Energy Operations | |
| 6.2 | Regional Operations | |
| 6.3 | Transmission Access and Transport Engineering | |
| 6.4 | Core Network Engineering – CNE, Cybersecurity and Assurance | |
| 6.5 | Radio Access Network Engineering | |
| 6.6 | Enterprise Technology and FFTX Group | |
| 6.6 | Technology Strategy Arc and Assurance | |
| 6.7 | Network Programme Management | |
| 6.8 | Other: [Open-ended] | |

**6. State your highest level of education.**

| No. | State your highest level of education | Tick |
|---|---|---|
| 7.1 | High school | |
| 7.2 | Diploma or equivalent | |
| 7.3 | Bachelor's degree or Honours degree | |
| 7.4 | Master's degree or Doctoral degree | |
| 7.5 | Other: [Open-ended] | |

**SECTION B:** This section seeks to identify the primary challenges facing a SA telecommunications organisation in transitioning to green ICT.

Please indicate your response by placing a tick (√) in the appropriate box. Kindly rate the following statements regarding the challenges and barriers affecting the adoption of green ICT within your department. Use the following scale based on your experience and understanding.

| No | Variable | 1 Strongly disagree | 2 Disagree | 3 Neutral | 4 Agree | 5 Strongly agree |
|---|---|---|---|---|---|---|
| B1 | The cultural and social challenges hinder the adoption of green ICT in the Organisation. | | | | | |
| B2 | The knowledge and communication challenges hinder the adoption of green ICT in the Organisation. | | | | | |
| B3 | The market and demand challenges hinder the adoption of green ICT in the Organisation. | | | | | |
| B4 | The employees' reluctance to change is a challenge in adopting green ICT within the organisation. | | | | | |
| B5 | The cultural norms within the organisation limit the effectiveness of green ICT initiatives. | | | | | |
| B6 | The leadership support is essential to overcoming cultural resistance to green ICT implementation. | | | | | |
| B7 | There is sufficient understanding of green ICT principles among employees in the organisation. | | | | | |
| B8 | The current communication strategies promote green ICT awareness effectively in the organisation. | | | | | |
| B9 | The lack of green ICT training is a significant barrier in the transition process. | | | | | |
| B10 | The customer expectations for green ICT influence the organisation's strategic planning | | | | | |

| No | Variable | 1 Strongly disagree | 2 Disagree | 3 Neutral | 4 Agree | 5 Strongly agree |
|---|---|---|---|---|---|---|
| B11 | A lack of market demand for green ICT services hinders its adoption within the organisation. | | | | | |
| B12 | The competition in the telecommunications industry impacts green ICT adoption within my department. | | | | | |
| B13 | The organisation's technological infrastructure is adequately prepared for a transition to green ICT. | | | | | |
| B14 | The financial burden of implementing green ICT is a challenge in my department. | | | | | |
| B15 | My department is ready to implement green ICT practices compared to other departments. | | | | | |

**SECTION C:** This section seeks to evaluate the current state of green ICT adoption within Organisation A.

Kindly rate the following statements regarding the effectiveness and adoption of green ICT practices based on your experience within your department.

| No. | Variable | 1 Strongly disagree | 2 Disagree | 3 Neutral | 4 Agree | 5 Strongly agree |
|---|---|---|---|---|---|---|
| C1 | Organisation A's green ICT practices reduce the environmental impact. | | | | | |
| C2 | The green ICT initiatives in my department are regularly reviewed and updated. | | | | | |
| C3a | Energy efficiency practices in my department are effective. | | | | | |
| C3b | Sustainable design and production practices in my department are effective. | | | | | |

| No. | Variable | 1<br>Strongly disagree | 2<br>Disagree | 3<br>Neutral | 4<br>Agree | 5<br>Strongly agree |
|---|---|---|---|---|---|---|
| C3c | E-waste management practices in my department are effective. | | | | | |
| C3d | Renewable energy practices in my department are effective. | | | | | |
| C3e | Virtualisation and cloud computing practices in my department are effective. | | | | | |
| C3f | Remote work practices in my department are effective. | | | | | |
| C3g | Network efficiency practices in my department are effective. | | | | | |
| C3h | Green standards and policies in my department are effective. | | | | | |
| C3i | Research and innovation practices in my department are effective. | | | | | |
| C4 | I am well-informed about the green ICT policies and guidelines implemented by Organisation A. | | | | | |
| C5 | Organisation A provides sufficient resources to support the adoption of green ICT practices in my department. | | | | | |
| C6 | Green ICT initiatives in my department are regularly monitored to assess their impact and effectiveness. | | | | | |
| C7 | Organisation A offers adequate training to employees to ensure successful implementation of green ICT practices. | | | | | |

**SECTION D:** This section seeks to investigate the challenges and barriers that impact Organisation A's transition to green ICT.

Kindly rate the following statements regarding the challenges and barriers that affect the adoption of green ICT practices based on your experience within your department.

| No. | Variable | 1<br>Strongly disagree | 2<br>Disagree | 3<br>Neutral | 4<br>Agree | 5<br>Strongly agree |
|---|---|---|---|---|---|---|
| D1 | The readiness challenges hinder the adoption of green ICT in the Organisation. | | | | | |
| D2 | The organisational and strategic barriers hinder the adoption of green ICT in the Organisation. | | | | | |
| D3 | The technical and infrastructure barriers hinder the adoption of green ICT in the Organisation. | | | | | |
| D4 | The financial barriers hinder the adoption of green ICT in the Organisation. | | | | | |
| D5 | The policy and regulatory barriers hinder the adoption of green ICT in the Organisation. | | | | | |
| D6 | The external and physical barriers hinder the adoption of green ICT in the Organisation. | | | | | |
| D7 | The lack of strategic alignment across departments affects the adoption of green ICT. | | | | | |
| D8 | The organisational leadership has prioritised green ICT in the company's overall strategy. | | | | | |
| D9 | The lack of coordination between departments hinders the implementation of green ICT policies. | | | | | |
| D10 | The technical limitations of the existing ICT infrastructure prevent green ICT adoption. | | | | | |
| D11 | My department has sufficient infrastructure to support green ICT initiatives. | | | | | |
| D12 | The need for new technology investments is a significant barrier to green ICT adoption. | | | | | |
| D13 | The cost of upgrading infrastructure to support green ICT is a significant barrier. | | | | | |

| No. | Variable | 1<br>Strongly disagree | 2<br>Disagree | 3<br>Neutral | 4<br>Agree | 5<br>Strongly agree |
|---|---|---|---|---|---|---|
| D14 | The limited financial resources hinder the adoption of green ICT practices within the organisation. | | | | | |
| D15 | The organisation is compliant with international green ICT standards and regulations. | | | | | |
| D16 | The external factors (e.g., power outages, load-shedding) hinder green ICT adoption. | | | | | |
| D17 | The geographical challenges (e.g., remote infrastructure) affect the adoption of green ICT. | | | | | |

**SECTION E:** This section seeks to determine the level of employee awareness, involvement, and perceptions regarding the green ICT initiatives in Organisation A.

Kindly rate the following statements regarding employee awareness, involvement, and perceptions of green ICT initiatives within your department.

| No. | Variable | 1<br>Strongly disagree | 2<br>Disagree | 3<br>Neutral | 4<br>Agree | 5<br>Strongly agree |
|---|---|---|---|---|---|---|
| E1 | I am aware of the green ICT initiatives implemented within the Organisation. | | | | | |
| E2 | I feel involved in the green ICT initiatives in the Organisation. | | | | | |
| E3 | The green ICT initiatives are effective in improving Organisation A's sustainability. | | | | | |
| E4 | The communication regarding green ICT initiatives within the Organisation is effective. | | | | | |
| E5 | Organisation A's culture supports green ICT initiatives. | | | | | |

| No. | Variable | 1 Strongly disagree | 2 Disagree | 3 Neutral | 4 Agree | 5 Strongly agree |
|---|---|---|---|---|---|---|
| E6 | Green ICT initiatives align well with Organisation A's overall strategic goals. | | | | | |
| E7 | My department is engaged with green ICT initiatives. | | | | | |
| E8 | Organisation A is committed to green ICT initiatives. | | | | | |
| E9 | Stakeholders are adequately engaged in supporting green ICT initiatives in the Organisation. | | | | | |

**SECTION F: Recommendations on strategies**

This section seeks to provide recommendations on strategies for Organisation A to overcome challenges and barriers in their green ICT implementation process.

Please provide any suggestions which you may have on strategies for Organisation A to overcome challenges and barriers in their green ICT implementation process.

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**Thank you for your participation.**

## ANNEXURE F: STATISTICIAN CONFIDENTIALITY AGREEMENT



**UNISA RESEARCH ETHICS 3rd Party Confidentiality Agreement**
**(Transcriber, Co-coder, Statistician and/or Fieldworkers)**

**A. INSTRUCTIONS**

**Please read through the entirety of this form carefully before signing.**

After completing the required fields, please sign the form. After this form has been signed by the transcriber, co-coder, statistician or fieldworker, it should be given to the principal researcher for submission to the relevant UNISA Research Ethics Committee.

The transcriber, co-coder, statistician and/or filedworker should keep a copy of the *Confidentiality Agreement* for their records.

**B. CONFIDENTIALITY OF A RESEARCH STUDY**

Confidentiality is the treatment and maintenance of information that an individual has disclosed in a relationship of trust and with the expectation that it will not be divulged to others in ways that are inconsistent with the understanding of the original disclosure (the informed consent documentation) without permission. Confidential information relating to human participants in a research study may include, but is not limited to the personal information listed below:

a) information relating to the race, gender, sex, pregnancy, marital status, national, ethnic or social origin, color, sexual orientation, age, physical or mental health, well-being, disability, religion, conscience, belief, culture, language and birth of the person;
b) information relating to the education or the medical, financial, criminal or employment history of the person;
c) any identifying number, symbol, e-mail address, physical address, telephone number, location information, online identifier or other assignment to the person;
d) the biometric information of the person;
e) the personal opinions, views or preferences of the person;
f) correspondence sent by the person that is implicitly or explicitly of a private or confidential nature or further correspondence that would reveal the contents of the original correspondence;
g) the views or opinions of another individual about the person; and
h) the name of the person if it appears with other personal information relating to the person or if the disclosure of the name itself would reveal information about the person.

Form adapted from the confidentiality agreement developed by the University of St Thomas IRB, retrieved from https://www.stthomas.edu

As a third party you will have access to research information (e.g. audio or video recordings, DVDs/CDs, transcripts, data, etc.) that include confidential information. Participants have revealed information to the researcher(s) since they have been assured by the researcher(s) that every effort will be made to maintain their privacy throughout the study. That is why it is of the upmost importance to maintain confidentiality when conducting your duties as a transcriber, statistician, co-coder and/or fieldworker during the research study. *Below is a list of expectations you will be required to adhere to in your role as a third party in this study. Review these expectations carefully before signing this form.*

**C. THIRD PARTY EXPECTATIONS**

**To maintain confidentiality, I agree to:**

1. Keep all research information that I collect or that is shared with me confidential by not discussing or sharing this information verbally or in any format with anyone other than the principal researcher of this study;

2. Ensure the security of research information (e.g. audio or video recordings, DVDs/CDs, transcripts, data, etc.) while it is in my possession. This includes:

- Keeping all data and/or transcript documents and digitized interviews on a password protected computer with password-protected files;
- Closing any programs and documents when temporarily away from the computer;
- Keeping any printed transcripts or data in a secure location such as a locked file cabinet;
- Permanently deleting any digital communication containing the data.

3. Not make copies of research information (e.g. audio or video recordings, DVDs/CDs, transcripts, data, etc.) unless specifically instructed to do so by the principal researcher;

4. Give all research information (e.g. audio or video recordings, DVDs/CDs, transcripts, data, etc.) and research participant information, back to the principal researcher upon completion of my duties as a transcriber;

5. After discussing it with the principal researcher, erase or destroy all research information (e.g. audio or video recordings, DVDs/CDs, transcripts, data, etc.) that cannot be returned to the principal researcher upon completion of my duties in this study.

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Name of 3rd party involved in research activities: Prof Philip Serumaga-Zake

Research activity responsible for (transcribing interviews, co-coding of data, statistical analysis, collecting data, etc.): Statistical analysis

Title of Research Study: Challenges in transitioning to green ICT in a South African telecommunication company

Name of Principal Researcher: Sivapragasen Naidoo

**By signing this form, I acknowledge that I have reviewed, understand, and agree to adhere to the expectations described above. I agree to maintain confidentiality while performing my duties as acquired**

Form adapted from the confidentiality agreement developed by the University of St Thomas IRB, retrieved from https://www.stthomas.edu

**by the principal researcher. I recognise that failure to comply with these expectations may result in legal action.**

03/09/2024

Signature of 3rd party

Date

Professor Philip AE Serumaga-Zake

Print Name

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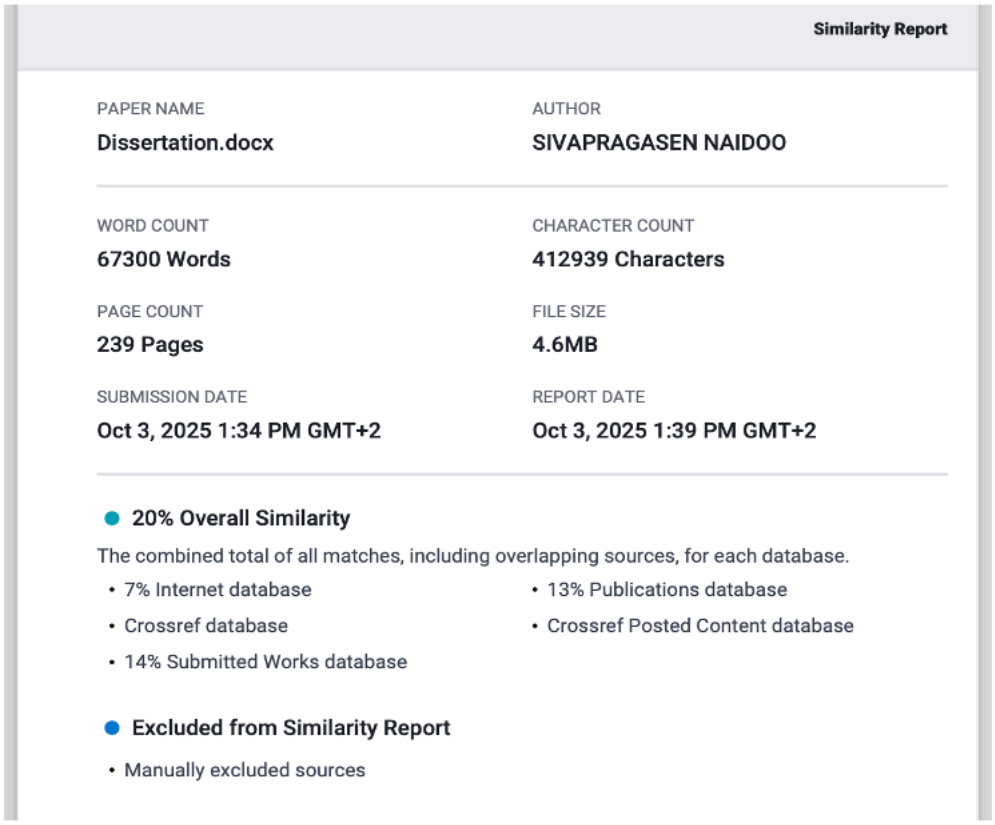
## ANNEXURE G: TURNITIN ORIGINALITY REPORT



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**Challenges in transitioning to green ICT in a South African telecommunication company**

by
Sivapragasen Naidoo

Student no.: 40510859

**In the fulfilment of the requirements for**
**Master of Commerce in Business Management**

**in**
**Operations Management**

**at the**
**UNIVERSITY OF SOUTH AFRICA**

**SUPERVISOR: Prof B Sookdeo**

**Date: 3 October 2025**

**ANNEXURE H: EDITOR'S CERTIFICATE**

Proof of edit by

# Michelle du Bruyn
## Copy Editor/Proofreader

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**27/10/2025**

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