UNIVERSITY OF GHANA

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ASSESSING THE EFFECTIVENESS OF GREEN COMPUTING IMPLEMENTATION IN HIGHER EDUCATIONAL INSTITUTIONS: THE CASE OF GHANAIAN UNIVERSITIES

BY

RHODA OSEI OWUSU

DEPARTMENT OF OPERATIONS AND

MANAGEMENT INFORMATION SYSTEMS

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(10934510)

A THESIS SUBMITTED TO THE DEPARTMENT OF OPERATIONS AND MANAGEMENT INFORMATION SYSTEMS, UNIVERSITY OF GHANA BUSINESS SCHOOL, UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF AN MPHIL IN MANAGEMENT INFORMATION SYSTEMS DEGREE

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MANAGEMENT INFORMATION SYSTEMS

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DECLARATION

I do hereby declare that this work is the result of my own research and has not been presented by anyone for any academic award in this or any other university. All references used in this work have been fully acknowledged.

I therefore bear responsibility for any shortcomings.

…… 17/09/2024

RHODA OSEI OWUSU DATE

…… 17/09/2024

DR. ACHEAMPONG OWUSU DATE

(SUPERVISOR)

..RICHARD BOATENG …… ……17/09/2024……

PROF. RICHARD BOATENG DATE

(CO-SUPERVISOR)

ABSTRACT

The advancement in technology has led to the use of computers in all sectors of the economy, including educational institutions. The rise of technology and the use of computers and electronic devices in Higher Educational Institutes (HEIs) have led to significant energy consumption, increased cost, electronic waste generation, and carbon footprints; these are a major concern for the managers of these Ghanaian HEIs, government and the public in general. Green computing (GC) though a nascent field has been proposed as a solution to the negative effects of computers. Educational institutions worldwide realizing the benefits of GC has led to its adoption and implementation. Though the concept of GC has attracted interest from different dimensions and researchers, there seems to be little focus on the post-adoption phase of GC, in terms of implementation, especially in the area of assessing its success or effectiveness.

Using the Resource-Based View (RBV) and Dynamic Capabilities (DC) as theoretical lenses, a conceptual framework was developed to assess how resources and capabilities influence effective GC implementations leading to sustainable competitive advantage in Ghanaian Universities. The study employed a cross-sectional survey design where data was collected using a structured questionnaire and administered to a stratified sample of 134 respondents. These included Information Technology Directors, Information Systems (IS) and Information Technology (IT) faculty members, IS and IT decision makers, IT procurement officers, IS and, IT staff, etc. about the status and implementation of GC in private and public HEIs in Ghana.

Descriptive and statistical analyses were conducted using SPSS 25 and Smart PLS 4 to analyze quantitative data for the conceptual framework. A survey of GC awareness and familiarity in the sampled Ghanaian Universities showed that 86.5 percent of respondents were familiar with GC concept. The findings reveal that a significant portion of the respondents perceived GC implementations as having minimal to negligible relevance to their university's operations as a

result of a lack of strong, explicit commitment to energy efficiency and environmental sustainability from the top management within these institutions. The results further revealed that for GC implementation to be effective in HEIs, top managers of universities should prioritize the allocation and efficient use of resources to facilitate effective GC implementation and strategically invest in them to be better positioned to lead their universities towards sustainability. Despite this, the study observed that the style of leadership and the presence of a green organisational culture do not significantly alter the impact of effective GC implementation on the universities' ability to maintain a sustained competitive advantage. The outcomes of this study have significant relevance and provide valuable insights for the academic community, IT professionals, and policymakers. The study underscored that Leadership commitment, resource allocation, and strategic investment are crucial for effective GC implementation in HEIs in Ghana. However, while organisational culture and leadership style are important in many contexts, the study found that these do not significantly affect the effectiveness of GC implementation in maintaining a competitive advantage.

In this regard, the study recommends that top management should create a comprehensive plan for GC that includes clear objectives, resource allocations, and timelines to guide effective implementation and integrate sustainability into the institution's strategic goals. Finally, the researcher suggests that future studies could consider other sectors of the economy and employ qualitative or mixed-method approaches to complement the quantitative findings of this study to provide a more nuanced perspective on how GC practices impact competitive advantage.

DEDICATION

To my wonderful and supportive husband, Mr. Kwakye Akwasi Owusu, my son, and future generation, the reason I keep striving for greater heights and accomplishments.

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LIST OF ABBREVIATIONS

AMMUSTED	Akenten Appiah Menkah University of Skills Training and Entrepreneurial Development
CSF	Critical Success Factors
CSUC	Christian Service University College
DC	Dynamic Capability Theory
GC	Green Computing
GICT	Green Information and Communication Technology
GIMPA	Ghana institute of Management and Public Administration
GIT	Green Information Technology
GIS	Green Information Systems
GUC	Garden City University College
HEIs	Higher Educational Institutions
IEEE	Institute of Electrical and Electronics Engineers
ICT	Information Communication Technology
IT	Information Technology
IS	Information Systems
KNUST	Kwame Nkrumah University of Science and Technology
KsTU	Kumasi Technical University
NAB	National Accreditation Board

OMIS	Department of Operations and Management Information Systems
RBT	Resource-Based Theory
RBV	Resource-Based View
SCA	Sustained Competitive Advantage
UCC	University of Cape Coast
UENR	University of Energy and Natural Resources
UG	University of Ghana
UMaT	University of Mines and Technology
UniMAC	University of Media, Arts and Communications
UPSA	University of Professional Studies, Accra
VRIN	Valuable, Rare, Inimitable, Non-substitutable

CHAPTER ONE

INTRODUCTION

1.1 Research Background

Information Technology (IT) has evolved into a fundamental commodity (Manocha & Upadhyaya, 2019; Cataldo & McQueen, 2014) which has profoundly transformed modern life by altering how we live, work, learn, and even play (Mohabuth, 2022; Manocha & Upadhyaya, 2019; Raza, Patle & Arya, 2012). Globally, technology has and continues to transform all sectors of the economy, including that of African (Al-Emran & Griffy-Brown, 2023; Hughes et al., 2019) in particular, the education sector (Manocha & Upadhyaya, 2019; Ali, Wood-Harper & Mohamad, 2018). In a rapidly evolving world and technology, organisations that seek to safeguard their future and gain competitive advantage need to innovate (Mohabuth, 2022; Salles et al., 2022; Coccia & Watts, 2020; Lee et al., 2019).

As the world becomes increasingly dependent on technology, the demand for computing resources continues to grow (Mohabuth, 2022; Salles et al., 2022; Turek, Dziembek, and Hernes, 2021). Computers use have spread in all types of organisations for different functions due to their ability to process, store and retrieve large amounts of data at faster speed and cheaper cost (Sinha & Sinha, 2022; Vaishnav & Bairagee, 2020) which has led to increased productivity and improved services and product offerings (Mohabuth, 2022; Turek et al., 2021). However, this growth has come at a cost, as the energy consumption associated with computing infrastructure has risen significantly in recent years, accounting for about 50% of the overall energy costs for an organisation (Schneider et al., 2023), increased carbon footprints (Nyabuto, 2024; Turek et al., 2021) and about 1% to 2.5% electricity used globally (Meadows, 2023).

The European Union indicates that Information Communication Technology (ICT) now contributes to about 2.1% to 3.9% of total carbon emissions (Rolling Plan for ICT Standardisation, 2023).

The combined energy required to operate these devices, along with the electricity needed to sustain the cooling infrastructure for these computing systems and related equipment, has an environmental impact (Mohabuth, 2022; Wang et al., 2021; Turek et al., 2021; Saha, 2018). Every stage of a computer's life cycle, from its design and production to its usage and disposal, has an associated environmental impact (Schneider et al., 2023; Mohabuth, 2022; Turek et al., 2021). The use of traditional computing infrastructure has resulted in a significant increase in greenhouse gas emissions (Paul et al., 2023; Mohabuth, 2022; Turek et al., 2021; Saha, 2018). The global IT sector accounts for about 2 to 3 percent of the world's total carbon dioxide emissions (Mohabuth, 2022; Marques et al., 2019), equivalent to that of the aviation industry (Obi & Orga, 2024). This has contributed to climate change that has adverse effects on humans, animals, and plants (Addaney, Cobbinah & Akudugu, 2021; Bradu et al, 2023).

Green computing (GC) has emerged in both practitioner reports (Climate Group, 2022; Info~Tech, 2023) and academic articles (Mohabuth, 2022; Ahmed et al., 2022; Lee, 2020) as a new approach to designing, operating and disposing environmentally friendly computing systems (Paul et al., 2023; Mohabuth, 2022; Salles et al., 2022; Sultana et al., 2016; Subburaj, 2014). Sultana et al. (2016) defined GC as the approach to designing, producing, utilizing, and disposing of computing devices to minimize their impact on the environment. GC aims to address environmental sustainability through power management, virtualization, improving cooling technology in Data centers, IT infrastructure optimization, telecommuting, recycling, and electronic waste disposal (Abdullah & Lim, 2023; Paul et al., 2023; Salles et al., 2022; Dhaini et al., 2021). Though a nascent field (Paul et al., 2023; Rogers, 2022; Ribeiro et al.

2021), GC has attracted interest from different researchers (Paul et al., 2023; Mohabuth, 2022; Salles et al., 2022; Lasrado & Zakaria, 2020; Bai et al., 2017; Freeman & Baa-Acquah, 2017; Asabere et al., 2016) due to the increasing concern for environmental sustainability. Increasing awareness about global warming and climate change has forced many organisations, and even individuals to be concerned and review their environmental footprints (Ahmed et al., 2022; Salles et al., 2022; Lee, 2020; Turek et al., 2021; Agarwal & Nath, 2011) through following stringent energy regulation, sustainable policy, energy efficiency and environmentally safe practices (Climate Group, 2022). This has led to its mass adoption by dynamic organisations in all sectors of the economy (Paul, 2023; Othman et al., 2022) who apply the use of knowledge, quality, and environment-friendly practices as valuable strategies to gain a competitive edge in today's business environment (Al-Qudah et al., 2022). The United Nations as part of its Sustainable Development Goals (SDGs) has championed environmental sustainability agenda specifically with SDG goal 7 (affordable and clean energy), SDG goal 11 (sustainable cities and communities), and SDG goal 13 (Climate action) forcing UN member states and organisations, including universities that operate within these countries to meet these goals (UNDP, 2023).

Higher educational institutions (HEIs), such as universities, have a critical role to play in promoting and implementing GC initiatives. These institutions rely heavily on technology and computing resources to support their academic, research, and administrative activities (Mohabuth, 2022; Khouja, Rodriguez, Halima, & Moalla, 2018; Uddin, Okai, & Saba, 2017; Ali et al., 2014) investing huge sum of monies to support their digitization agenda (Manocha & Upadhyaya, 2019).

The rise of technology and the use of electronic and computing resources in HEIs have led to significant energy consumption, increased costs, and carbon footprints (Mohabuth, 2022;

Uddin et al., 2017). These invariably are a major concern for the top managers of these HEIs, the government, and the public in general (Opoku et al., 2020; Asabere et al., 2016). With the growing importance of sustainability, Universities worldwide are ranked in terms of their role in environmental sustainability (Ragazzi & Ghidini, 2017). The above discussions give credence to the adoption and implementation of GC in HEIs since it has the potential to reduce energy consumption; high operational expenses, carbon footprints, and greenhouse gas emissions through eco-friendly use and disposal of electronic and computing equipment (Mohabuth, 2022; Asadi et al., 2021; Turek et al., 2021; Uddin et al., 2017).

Additionally, it has the potential to give a competitive advantage to the implementing institution over competitors who have not taken the innovative opportunity to implement GC (Mahmood, Ahmed, & Philbin, 2023; Khanra et al., 2022). Gaining competitive advantage could mean, using the distinct capabilities, assets, and resources of the organisation (Khanra et al, 2022; Azeem et al., 2021; Sayeed & Gill, 2009) to meet the increasing demands of various environmental groups and government regulations and to implement measures for reducing its environmental impact (Ahmed et al., 2022; Asadi et al., 2021). Therefore, this study aimed to adopt the RBV and DC theories to assess the unique and valuable resources available to HEIs that have a significant impact on effective GC implementation that leads to sustained competitiveness.

Excitedly, scholars in Ghana have turned their attention to the concept of GC. For example, there is evidence of studies on GC awareness, adoption, and implementation in HEIs in Ghana (Asabere et al., 2016; Freeman, 2016). Ghana has a growing higher educational sector with 16 public and over 100 private universities (Ghana Tertiary Education Commission (GTEC) 2022), with an increasing demand for technology and computing resources.

Although many universities, especially in Ghana have implemented some form of GC initiatives, there is little evidence of the degree of their success (Mohabuth, 2022; Asabere et al., 2016; Freeman, 2016). This relevant issue needs addressing since any technology implementation, has an associated success or failure. There is therefore the need to assess the effectiveness or ineffectiveness of GC implementation in HEIs in Ghana.

1.2 Research Problem

The education sector, often overlooked in environmental impact discussion, is considered a significant contributor to environment degradation (Adjei, Addaney & Danquah, 2021; Opoku et al., 2020), attributed to the fact that most of their activities contribute to waste generation and carbon emission (Adjei et al., 2021; Edumadze et al., 2013). This sheds light on the need for sustainable practices within educational institutions to mitigate their ecological footprints (Mohabuth, 2022; Adjei et al., 2021; Opoku et al., 2020; Edumadze et al., 2013). GC has been proposed as a proactive solution (Paul et al., 2023; Mohabuth, 2022; Ahmed et al., 2022; Adjei et al., 2021; Lee, 2020; Sultana et al., 2016), which has led to its mass adoption and implementation in the education sector, particularly, HEIs (Uddin et al., 2017; Freeman, 2016; Asabere et al, 2016). However, the effectiveness of its implementation is lacking in recent literature (Paul et al, 2023; Salles et al., 2022; Asadi et al., 2021; Asadi et al., 2017) leading to many unanswered questions on the actual success of GC.

In other words, little evidence of studies measuring or assessing GC implementation effectiveness exists in both developed and developing economies (Paul et al., 2023; Asadi, Hussin, & Dahlan, 2017; Tushi, Sedera & Recker, 2014; Sayeed & Gill, 2009). Paul et al. (2023) reviewed 216 articles published in 2020 and pointed out that academic research on GC has advanced in numbers and quality, however post-adoption phase of GC is still lacking due to several delimiters such as insufficient funding, inadequate resources, and technical expertise

and capabilities. Asadi et al. (2017) in their review of 200 articles on Green IT from 2007 to 2016 indicated that most studies on GC focused on initiation, adoption, benefits, strategies, and approaches, excluding its implementation in organisations. Additionally, Nyabuto (2024) examined 75 open-access papers on GC published in the IEEE journal from 2020 and 2023 but noted a lack of focus on the effectiveness of GC concept. However, the implementation and effectiveness of GC should be a critical concern for businesses dealing with energy limitations and addressing environmental issues as part of their social responsibility (Asadi et al., 2021).

According to Ribeiro et al. (2021), research on GC is categorized into three phases, namely pre-adoption, adoption, and post-adoption. In developed economies, extant studies have focused primarily on understanding the readiness, determinants, and barriers to adoption, the extent of awareness, knowledge, and practice of GC (Paul et al., 2023; Khandelwal et al, 2019; Mbewe, 2019; Paul & Ghose, 2018; Loke et al., 2014). Conversely, Nyabuto (2024) and Paul et al. (2023), reviewed articles and identified that research on GC is still lacking in developing countries. In the Ghanaian context, there have been few studies on GC concept in all three phases of GC research. Available studies have focused primarily on GC adoption, practices, the development of a sustainable GC model for computer users, and strategies for GC implementation (Freeman, 2016; Asabere et al, 2016). Freeman (2016) assessed the current state of GC adoption and practices in HEIs and came up with a sustainable conceptual model for computer users. Asabere et al. (2016) outlined possible green ICT implementation strategies in polytechnic education in Ghana. Again, Asabere et al. (2016) studied the importance of GC awareness and acceptance in building the capacity of ICT personnel essential for Green ICT implementation. Despite the increasing research popularity and benefits of GC, a review of the available literature shows that the factors accounting for effective or successful GC implementation in organisations are under-explored in developing countries, especially in the Ghanaian context.

Furthermore, though there are several Information System (IS) theories available for use to determine or evaluate the success, performance, or effectiveness of technology adoption at the firm level, few, specifically Delone and Mclean's IS Success and Critical Success factors theory are mostly used in many technology adoption studies (Owusu, Akpe-Doe, & Taana, 2022; Shagari, Abdullah, & Mat Saat, 2015). In many technology adoption studies such as E-governance (Owusu et al., 2022), E-learning (Ansong, Boateng, & Boateng, 2017), and Cloud Business Intelligence (Owusu, Broni, Penu, & Boateng, 2020), these theories have been used extensively. These theories are purported to have been over-used by researchers (Talukder, & Quazi, 2017) in determining or measuring technology adoption success. As a result, most researchers have formed their conceptual frameworks to determine the success, impact, or effectiveness of technology adoption and implementation. For this reason, this study adopts the RBV and DC theories as theoretical lenses to offer a nuanced understanding of how internal capabilities and resources contribute to sustainable competitive advantage, especially in technology-driven initiative live GC. Sayeed and Gill (2009), pointed out that many researchers have stressed the importance of conducting studies on dynamic resources (Eisenhardt & Martin, 2000; Teece, Pisano & Shuen, 1997). However, little of such research has been conducted in response. Asadi et al. (2017) also found that the Resource Based Theory was the second most used theory in GC studies from 2007 to 2017.

The RBV asserts that competitive advantage is achieved through an organisation's unique internal capabilities and resources. These distinctive elements are the primary drivers of profit and shape the organisation's long-term strategy (Loeser et al., 2011). For these reasons, there was the need to combine the RBV and the DC theories to understand the inherent factors that is resources, assets, capabilities, and agility of HEIs that contribute to effective GC implementation leading to the attainment of sustainable competitive advantage (Cooper et al.,

2012). In other words, the extent to which these factors have enabled or hindered the HEIs efforts to implement sustainable computing practices.

This study will be one of the few, if not the first in Ghana, to focus on assessing the effectiveness of GC implementation from the perspective of HEIs using the RBV and DC theories.

1.3 Research Purpose

The purpose of this study is to assess the implementation effectiveness of GC in Ghanaian Universities. The study will also assess the impact of effective GC implementation on Universities' sustainable competitive advantage.

1.4 Research Objectives

To achieve the purpose of the study, the following were the objectives of the research,

1. To assess the current state of GC implementation in Ghanaian Universities
2. To assess the implementation effectiveness of GC in Ghanaian Universities
3. To assess the impact of GC implementation effectiveness on universities' sustainable competitive advantage
4. To assess the moderating effects of organisational culture and leadership style on the relationship between effective GC implementation and universities' sustainable competitive advantage.

1.5 Research Questions

Primarily, the study addressed the following questions.

1. What is the current state of GC implementation in Ghanaian Universities?
2. What factors account for effective GC implementations in Ghanaian Universities?
3. What is the impact of GC implementation effectiveness on universities' sustainable competitive advantage?
4. What are the moderating effects of organisational culture and leadership style on the relationship between effective GC implementation and universities' sustainable competitive advantage?

1.6 Research Significance

The contribution of this study is manifold, advancing practice, policy, and research knowledge. For research knowledge, few studies, especially in developing countries, assessing the effectiveness of GC initiatives have been conducted. The study therefore filled the scarcity gap in a critical research area in terms of the adoption, implementation, and assessment of GC implementation effectiveness in the educational sector. It also provided valuable data for research studies aimed at understanding the impact of sustainability practices in institutions. Researchers can analyze the data to identify trends, develop new sustainability models, and make recommendations for future research.

For practices, the study identified best practices that can be shared across institutions leading to the development of practical solutions for improving environmental sustainability in the digital age. It also served as a guideline for use by other educational institutions and firms who anticipate implementing GC initiatives in their organisations to improve environmental sustainability.

For policy, the findings and recommendations of this study inform policy development aimed at promoting sustainability in the HEIs. In addition, the information gathered will help policy makers identify areas where regulations are necessary to encourage sustainable practices in HEIs.

1.7 Chapter Outline

This thesis is organized into seven (7) chapters. Details of the chapters are as below.

Chapter One: This section contains an introductory to the study's background statement, a description of the research problem, as well as the purpose and objectives of the research. The chapter also addressed the major research questions and the significance of the study.

Chapter Two: It comprises the literature review, based on extant studies by other researchers; it delves deeper into the concept under study, research gaps, and directions for future studies.

Chapter Three: The third chapter focused on the research framework that guided the study including the conceptual framework and empirical perspective. The research framework guided the study's research design, data collection methods, and instrument and served as a standard for the data analysis and discussions.

Chapter Four: The fourth chapter is the methodology that guides the study. The chapter summarizes the study's philosophical stance, approach and design, research population, sample and sampling procedures, research and data collection instruments, and data analytical procedures.

Chapter Five: The chapter discussed the demographic characteristics of the respondents of the study. It also presented descriptive statistics of the scales used in measuring the constructs in the research model. Finally, reliability, validity, and the relationship between the measured constructs are analyzed and the results of the study are presented.

Chapter Six: This chapter analyzed the study's findings and the discussions thereof. The discussions focused on the relationships that exist between the independent and the dependent constructs of the conceptual framework. It also looked at how organisational green culture and leadership style moderate effective GC implementation and Universities sustained competitive advantage.

Chapter Seven: It comprised the summary, conclusions, and recommendations of the study. In addition, directions for future research on GC implementations were suggested. Finally, the references and appendices followed.

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Overview

As highlighted in the previous chapter, the concept of GC is attracting academic research, especially concerning its implementation and dynamic resources of organisations. This chapter begins with an overview of GC, including definitions, approaches to its application, dimensions, implementation strategies, benefits, challenges, factors for GC implementation success, and finally, a detailed look at GC implementation in HEIs in Ghana. Furthermore, the chapter presents a detailed review of related studies regarding GC to gain a deeper understanding and identify gaps for future studies. A summary concludes this chapter.

2.1.1 Overview of Green Computing

It is a fundamental axiom that if the present generation does not attempt to reduce their carbon footprints, Earth may no longer be habitable for future generations to come. At the heart of GC is eco-sustainability or sustainable development, which refers to addressing the needs of the current generation without compromising the capacity of future generations to meet their own needs (Singh & Sahu, 2020; Subburaj; 2014; Hart, 1997; World Commission on Environmental and Development (WCED); 1987). GC awareness and practice gained popularity in 1992 through the Energy Star initiative by the United States Environmental Protection Agency (Paul et al., 2023; Singh & Sahu, 2020). The energy star initiative is a voluntary labeling program created to promote and encourage energy efficiency in computer monitors, climate control systems, and other computing technologies (Singh & Sahu, 2020; Subburaj; 2014).

According to Asabere et al. (2016), there have been different definitions of GC, which has led to a lack of an agreed standard definition.

Some researchers perceive it to be Green IT (Asadi et al., 2021; Hernandez, 2020; Subburaj, 2014) others as Green ICT (Paul et al., 2023), and sometimes Green Information Systems (IS) (Singh & Sahu, 2020; Gholami et al., 2013). Lunardi et al. (2011) also share similar views and assert that Green IT is neither a well-defined term nor a set of widely accepted practices. Asabere et al. (2016) stressed the importance for nations, businesses, and decision-makers to understand, engage, and be aware of GC consequences and potential to attain a sustainable world (Hart 1997). To help understand the concept under study, Table 2.1 below elaborates some definitions of GC and other concepts adopted for the study.

Table 2.1: General Definitions of Green Computing

Author(s)	**Definition**
Paul et al. (2023, p. 87445)	"refers to practices that lessen the negative effects of technology on the environment"
Mohabuth (2022, p. 1)	"Focuses on the efficient and effective design, development, usage and disposal of computers together with its associated systems with minimal impact to the environment."
Salles et al. (2022)	Encompasses the creation of strategies and tools to steer and convey the green practices implemented by organisations.
Saha (2018, p. 467)	"the practices and procedures of designing, manufacturing, using of computing resources in an environment-friendly way while maintaining overall computing performance and finally disposing in a way that reduces their environmental impact."
Sultana et al.(2016)	The approach to designing, producing, utilizing, and disposing of computing devices to minimize their impact on the environment.

Murugesan (2010, p. 2)	"The study and practice of designing, manufacturing, using and disposing of computers, servers, and associated subsystems efficiently and effectively with no or minimal impact on the environment."
Dedrick (2010, p. 174)	"An effective way of achieving greater efficient use of energy and other resources while sustaining economic growth."
Elliot (2007, p. 107)	"the design, production, operation, and disposal of ICT and ICT-enabled products and services in a manner that is not harmful and may be positively beneficial to the environment during its whole-of-life"

Source: Author's construction

From the diverse definitions in Table 2.1, the researchers considered the entire life cycle of information and communication technology (ICT), that is, environmentally responsible design, manufacturing, operation, and disposal processes and ICT serving as a potential solution rather than a cause of environmental problems (Dedrick, 2010). Inferring from these definitions, for this study, GC comes to be understood as considering environmental sustainability in the life cycle of computing and digital technologies in-order to reduce power consumption and environmental impact, as well as developing strategies and tools to guide and promote enterprises' green practices.

In other words, GC emerges as an innovative way of merging existing organisational resources with sustainable and economic principles, resulting in benefits for both the environment and the implementing organisation.

2.1.2 Approaches to Green Computing Implementation

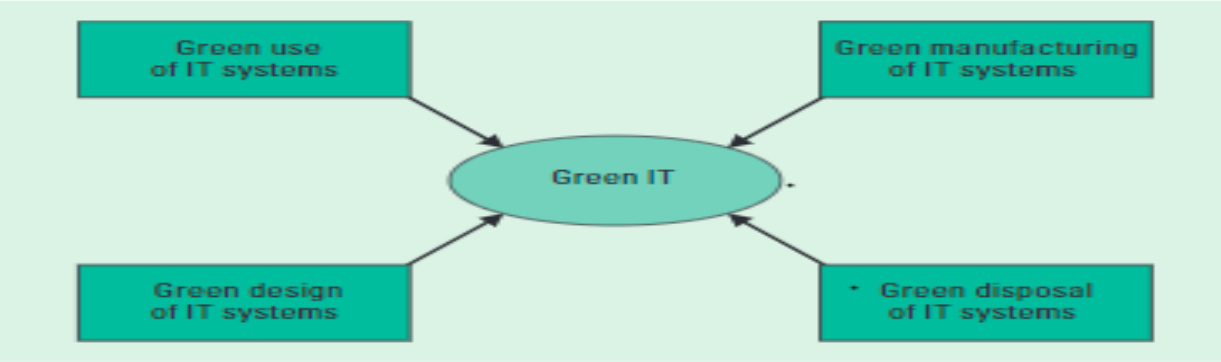
Several researchers have come up with different holistic approaches for the implementation of GC to address the environmental impacts of IT comprehensively and effectively. Murugesan (2008) earlier outlined four approaches to addressing the environmental impacts of computing: Green design, Green Manufacturing, Green use, and green disposal. Figure 2.1 depicts the four paths outlined by Murugesan (2008). These four paths are suggestive of the different ways through which GC may be implemented in other to be effective, efficient, and comprehensive to ensure computing and its associated subsystems have little to no negative affect on the environment (Khandelwal et al., 2019; Muladi & Surendro, 2014). Green design focuses on designing energy-efficient components, servers, projectors, printers, other digital devices, and cooling equipment (Sarkar & Gul, 2021). Examples of Green IT design are the transition from single-core to multi-core CPUs that consume much less power (Hoheisel et al., 2022) and the use of thin client computers, which enable computer applications to run on a network server rather than on individual users devices. This way, less energy is consumed in thin-clients computers as compared to typical high-end desktop computers (Hoheisel et al., 2022; Sarkar & Gul, 2021). Green manufacturing entails implementing green practices right at the manufacturing stage of computing devices with minimal impact on the environment (Nyabuto, 2024). Murugesan (2008) explained that green use is about reducing the energy consumption associated with the use of computing resources. Green disposal is concerned with repurposing old technology or properly discarding obsolete computers and electronic equipment. Murugesan (2008) argued that by applying GC, using the outlined approaches would enhance the robustness and sustainability of the IT lifecycle within the organisation.

Hasbrouck and Woodruff (2008) also highlighted two key aspects of GC, Minimize and Enable. The first focuses on reducing operational costs, while the second aims to decrease the carbon footprint of technology.

Muladi et al. (2014) emphasized that the choice of GC implementation approach varies depending on the type of organisation, primary product, and the use of IT in its business processes. The researchers categorized organisations into four, per IT usage in the organisation's business processes; namely IT as strategy, IT as an enabler, IT producers, and IT start-ups. Table 2.2 presents the categorization of an organisation according to IT usage in business processes and the required GC implementation approach to be adopted by an organisation.

Just like Muladi et al. (2014), Nolan and Mcfarlan (2005) presented a four-quadrant IT strategic grid. The quadrants namely "Strategic", "Turnaround", "Factory" and "Support" represent a possible role of IT in the organisation. The framework suggests that organisations are different, IT is of major strategic importance to some while it is of minimal importance to others. Therefore, each organisation requires a different IT/IS management approach. Nolan and Mcfarlan (2005) further explained strategic organisations as those with IT deeply embedded in their business processes and critical for successful business operations. In terms of turnaround organisations, IT supports operations but is not entirely dependent on it (Boateng, 2017, p. 100).

Figure 2.1: Green Computing Implementation Approaches



Source: Adopted from Murugesan, 2008

Table 2.2: Organisation Type and Appropriate GC Implementation Approach

No.	Organisation Type	GC Implementation Approach
1.	IT as Strategy	1. Usage 2. Disposal 3. Metrics and Measurements 4. Strategy and Policy
2.	IT as Enabler	1. Usage 2. Disposal 3. Strategy and Policy
3.	IT as Producers	1. Design 2. Production 3. Usage 4. Disposal 5. Metrics and Measurements 6. Strategy and Policy

4.	IT Start-ups	1. Design 2. Production 3. Usage 4. Disposal 5. Strategy and Policy

Source: Adopted from Muladi et al. (2014)

Building on the previous discussions, within the context of the institutions under study, HEIs in Ghana are organisations that primarily do not offer IT products or services but occasionally use IT for non-core business processes. This means that GC implementation can be approached from usage and disposal, as well as strategy and policy but not in design and manufacturing since HEIs do not have IT as their main product or services (Muladi & Surendro, 2014). In other words, HEIs do not design and manufacture IT products or services to incorporate GC initiatives right from the design and manufacturing stages.

2.1.3 Dimensions of Green Computing Implementation

Several studies have sought to propose different dimensions under which GC implementation can be effective in transforming an organisation, giving it an advantage over its competitors. For example, Cooper et al. (2012) emphasized the need for organisations to understand the key dimensions of Green IT, which will serve as a benchmark to measure their Green IT capability. They further explained that an understanding of the dimensions would help the organisations to develop and implement strategies to improve their Green IT capability.

Molla and Copper (2009) argued that there are at least five important properties necessary for success in greening IT. They proposed five dimensions or properties for GC including attitude, practices, policy, technology, and governance.

These different dimensions are indicative of the critical factors necessary for the success or effectiveness of GC implementations. Attitude refers "to an organisation's IT people sentiment, values, and norms toward climate change and eco-sustainability and IT role" (Molla & Copper, 2009, p. 12). Governance refers to "the IT management capability to put in place environmental criteria and frameworks to guide the sourcing, use, and disposal of the IT technical infrastructure and the activities of IT people" (Molla & Copper, 2009, p. 17).

Policy refers to "the operating model that defines the administration of Green IT initiatives, the allocation of budget, and other resources and the metrics for assessing impacts" (Molla & Copper, 2009, p. 12). Practice "pertains to the actual application and realization of eco-sustainability considerations in IT infrastructure sourcing, operation, and disposal" (Molla & Copper, 2009, p. 14). Finally, technology refers to "information technologies and systems for reducing the energy consumption of powering and cooling corporate IT assets, optimizing the energy efficiency of the IT technical infrastructure, reducing IT induced greenhouse gas emissions, supplanting carbon emitting business practices, and analyzing a business' total environmental footprint" (Molla & Copper, 2009, p. 16).

Furthermore, Unhelkar (2011) considered four dimensions for GC implementation including economy, process, people, and technology. The economy is about financial profit and arguably the most important dimension in organisational decision-making and a factor to consider when making any decision concerning GC adoption and implementation. Green IT encompasses the support of hardware, software, network infrastructure, applications, data center management, and cloud computing. This study however adopted Molla and Cooper's (2009) dimension to GC implementation. The adoption of Molla and Cooper's (2009) dimensions for GC implementation in this study is justified for several reasons, reflecting the comprehensiveness of the framework, adaptability, multidimensional approach, and its alignment with organisational strategies.

Ultimately, Molla and Cooper's (2009) has been extensively used in empirical research providing evidence-based best practices and its ability to provide indicators for implementing and measuring the effectiveness of GC initiatives (Amin, Molla & Adamopoulos, 2020; Onimbo, 2020; Wabwoba, 2019, Khan; Aljaberi & Muammar, 2019).

2.1.4 Strategies for Green Computing Implementation

GC initiatives require a concerted effort, therefore, there should be a plan that spells out how these initiatives will be achieved, else "it may lead to sinking resources into GC initiatives without seeing results anywhere near expected returns" (Molla & Cooper, 2009, p.16). This assertion means an organisation needs to strategize before, during, and after the implementation of GC. Strategy as explained by Mintzberg (1987; p.11) is "a plan, some sort of consciously intended course of action, a guideline (or set of guidelines) to deal with a situation".

Murugesan (2008) stated that organisations must holistically develop a comprehensive GC strategy, which should be aligned with the overall business strategy. He proposed the tactical-incremental, strategic, and deep green approaches as strategies for GC implementations. Tactical incremental involves maintaining the existing IT infrastructure and policies and incorporating easy-to-implement short-term measures to achieve GC goals (Murugesan, 2008). These short-term measures include reducing energy consumption by turning off computers that are not in use, maintaining an optimal room temperature, and using energy-saving light bulbs and energy-star-rated electronic appliances (Murugesan, 2008). The strategic approach of GC implementation requires an organisation to conduct an IT infrastructure audit from an environmental perspective and come out with a detailed plan to green its IT infrastructure (Murugesan, 2008). For instance, an organisation might introduce new energy-efficient and environmentally friendly computing systems and IT infrastructure, or create and enforce new procurement policies, operational procedures, and disposal practices for computing resources.

Although the primary purposes are cost efficiency and reduced carbon footprints, the strategic approach also incorporates other elements, such as the organization's corporate branding and marketing concerning environmental sustainability (Raja, 2021).

Finally, the deep green approach looks at organisations adopting strategies such as the implementation of a carbon offset policy, which seeks to mitigate greenhouse gas emissions by engaging in activities such as planting trees, purchasing carbon credits from various carbon trading platforms, or utilizing renewable energy sources like solar or wind power (Murugesan, 2008). Carbon credits or offsets are certificates that authorize the holder to release a certain quantity of carbon dioxide (CO2) or other greenhouse gases (Anukwonke & Abazu, 2022; Tripathi, 2019). One credit allows for the release of one ton of CO2 or the equivalent of other greenhouse gases (Tripathi, 2019).

Hedman and Henningsson (2011), share similar views with Murugesan (2008), who outlined three strategies for Green IT implementation, which are storefront, tuning, and redesign as shown in Table 2.3. Storefront strategy appears to be motivated by the need to meet legal requirements and establish a green image (Hedman & Henningsson, 2011). Tuning involves assessing existing business activities to enhance efficiency and resource use through green IT (Hedman & Henningsson, 2011). Redesign requires an organisation should adjust its internal structure, organisational charts, and business processes to capitalize on the benefits of green IT (Hedman & Henningsson, 2011).

Similarly, research by Asabere et al. (2016) found that successful green ICT can be achieved by implementing these strategies; increasing awareness and communicating the sustainability agenda to key stakeholders, and understanding the resource needs, issues, and costs associated with GC implementations.

Asabere et al. (2016) study also emphasized the importance of management continuously assessing the environmental impacts of their business activities. Finally, another strategy outlined by Asabere et al. (2016) was the need to update management with information about an organisation's energy and paper consumption.

HEIs in Ghana have transitioned from tactical incremental to strategic types of GC implementation strategies as proposed by Murugesan (2008). These measures include HEIs adopting short-term actions such as reducing energy consumption by turning off computers that are not in use, using energy-saving light bulbs, and energy star-rated electronic appliances. Additionally, this includes deploying new energy-efficient, environmentally friendly computing systems and IT infrastructure, updating data centers, and implementing new procurement policies, operational procedures, and disposal methods for computing resources.

Table 2.3: Three strategies for Green Computing Implementation

Strategy	Description	Example
Storefront	Without changing any of its business activities, the company reviews existing activities to see if it can present them as green IT.	Presentation of green IT projects on the company website and through external communications.
Tuning	The company investigates existing activities to see if it can improve efficiency and resource consumption by using green IT.	Implementing server virtualization, switching off computers, and using energy efficient hardware.
Redesign	The company alters its internal structure, organizational chart, and business processes to fully leverage green IT's potential.	Redesigning processes, identifying new business opportunities enabled by green IT, and changing corporate culture.

Source: Adopted from Hedman and Henningsson (2011)

2.1.5 Benefits of Green Computing Implementation in HEIs

Several studies have theorized that organisations can gain significant benefits from adopting and implementing GC initiatives (Ahmed, 2018; Loeser et al., 2017; Uddin et al., 2017; Ramaya et al., 2013). These benefits include environmental sustainability, cost saving through minimization of resource usage, reduction in power consumption, lowering carbon emission, cutting down operational expenses, and competitive advantage (Paul et al, 2023; Mohabuth, 2022; Ahmed, 2018; Loeser et al., 2017; Uddin et al., 2017; Ramaya et al., 2013; Molla & Cooper, 2009; Murugesan, 2008).

Primarily, one of the main advantages of adopting and implementing GC in organisations aiming to sustain their business operations is cost. Paul et al. (2023) and Gholami et al. (2017a) noted that an advantage of Green IT is the ability to lower business costs through compliance with environmental regulations as compared to other competitors who do not comply. GC can help universities in Ghana reduce their energy costs and improve their financial sustainability (Opoku et al., 2020). By reducing energy consumption, universities can lower their electricity bills and save money. As stipulated by Murugesan (2008), adopting green IT practices offers financial and other benefits to businesses and individuals.

Through the implementation of energy-efficient hardware and software, optimizing power management settings, and promoting sustainable computing practices such as virtualization and cloud computing, universities can reduce their carbon footprint, conserve natural resources, and promote environmental sustainability (Uddin et al., 2017). According to Uddin et al., (2017), while organisational IT infrastructure can add to carbon emissions, effective and intelligent use of IT can assist organisations in reducing their emissions.

GC can help universities in Ghana demonstrate their dedication to social responsibility and environmental stewardship. By adopting sustainable computing practices and reducing their environmental impact, universities can enhance their reputation, and strong environmental profile, and improve their green image and relationships with stakeholders such as students, faculty, staff, and the community (Purwanti, 2022; Uddin et al., 2017). Alniacik et al. (2011) define the reputation of a university as how society perceives and evaluates the distinct characteristics that set it apart from other competing institutions.

GC implementation can also provide opportunities for curriculum development in universities in Ghana (Lee et al., 2013, Mintz & Tal, 2013). By integrating GC into their courses and programs, universities can prepare students for careers in sustainability and environmental management. According to a study by Green (2013), incorporating GC into university curricula can help raise awareness of environmental issues, promote sustainable development, and enable the implementing university to progress. Other studies have recognized the ability of GC to sustain a competitive advantage (Tu & Wu, 2021; Singjai et al., 2018; Ugochukwu, Franklin & Ismail, 2014).

2.1.6 Challenges of GC Implementation in HEIs

Like any technology adoption, GC implementation comes with its associated challenges. However, it is important to address these challenges proactively to ensure the effectiveness of GC implementation initiatives in HEIs. Extant literature suggests several challenges associated with the implementation of GC such as resistance from stakeholders, cost implications, lack of awareness and knowledge of GC, and system incompatibility issues (Nyabuto, 2024; Hopkins 2016; Wu et al., 2012; Hedman & Henningsson, 2011).

Firstly, implementing GC practices might necessitate substantial changes to existing systems and processes, potentially encountering resistance from staff and students who are used to the status quo. As purported by Murugesan (2008) and Hedman and Henningsson (2011), the adoption of GC implementation strategies such as strategic and redesign respectively may require comprehensive changes to an organisation's existing internal IT infrastructure and business processes to fully leverage GC potential. Furthermore, Christensen and Overdorf (2000) maintained that Green IT represents a disruptive technological change. However, this disruption may only be apparent in the organisation during Green IT implementation (Mohabuth, 2022). For instance, the adoption of a web-based learning system known as the Knowledge Environment for Web-based Learning (KEWL) (Dadzie, 2009), a form of GC initiative received high resistance from faculty members at the University of Ghana (UG). Dadzie (2009) claimed that, after 3 years of the introduction of KEWL, only 27 lecturers from the Faculty of Science and Arts used the platform.

Marshall et al. (2005) and Ridgley (2009) identified that Green IT presents two challenges to organisational IT strategy and governance, which have previously focused on the economic value of IT and the ethical behavior of IT workers. First, is the need for organisations to consider environmental sustainability in their IT governance decision, and second, the expectation from IT managers to constantly develop new tools and capabilities required to support an organisation's carbon reduction and sustainability strategy (Turek et al., 2021).

According to Hopkins and Hopkins (2016), a lack of awareness, knowledge, and understanding of GC may pose as challenge to its implementation. Many staff and students may not be aware of the benefits of GC practices leading to a lack of enthusiasm or support for GC initiatives.

Thirdly, HEIs may have limited resources to invest in new hardware, software, or training needed to implement GC initiatives. This can make it difficult to achieve the desired level of energy efficiency and sustainability.

Another challenge with GC implementation is compatibility issues with existing network infrastructure. Some existing hardware or software may not be compatible with GC practices, which can make it difficult to implement them effectively. As an example, older university buildings may not have the network connectivity or proper building infrastructure to handle the changing technology growth. Furthermore, GC practices may require more maintenance and management than traditional computing practices, which can be time-consuming and require additional resources (Turek et al., 2021).

Lastly, green agenda comes with huge financial implications (Paul et al, 2023; Turek et al., 2021; Wu et al., 2012); however, it is economically beneficial in the long term (Turek et al., 2021; Walker & Brammer, 2009). Studies suggest that the initial investment in GC practices may be higher than traditional computing practices, which may not be perceived as a good deal for investors (Turek et al., 2021; Mosgaard et al., 2013). Although GC practices can lead to long-term cost savings, it can be difficult to justify the initial cost to stakeholders (Raja, 2021). For this reason, Geng (2013) proposed that getting top management support is crucial in the early stages of green implementation in other to mobilize organisational resources in developing and implementing green strategies (Turek et al., 2021; Zhu et al., 2013).

2.1.7 Factors that promote Effective Green Computing Implementations in HEIs

Several factors have been cited to promote effective GC implementation in HEIs including strong management support, collaboration, and engagement, resource availability; government policies (Ahmed, 2018; Zhu et al., 2013; Yuan, Zuo & Huisingh, 2013).

Ahmed (2018), in his study to understand the factors affecting the adoption of GC in the Gulf universities, classified the success factors for GC adoption and implementation into organisational, environmental, and technological. The study's findings were that organisational factors include awareness, relative advantage, management support, and adequate resources. While the environmental context includes government policy, legislative and regulatory environment, and finally, the technology dimension comprises outsourcing and IT infrastructure.

As suggested by prior studies, top management plays a vital role in IS adoption and implementation (Owusu & Boateng, 2021; Owusu, Broni, Penu & Boateng, 2020; Ofosu, Owusu & Broni, 2020; Owusu, Agbemabiasie, Abdurrahaman & Soladoye, 2017; Owusu & Moyaid, 2016). In the same vein, top management support and commitment are needed for GC implementation to be successful (Ram, Teoh, & Keni, 2023; Ahmed, 2018; Chen & Chang, 2014). This implies that the significance of strategic decisions regarding the adoption and implementation of GC depends on top management's support, which includes providing funding, allocating resources, and developing action plans for GC implementation. (Ram et al., 2023; Liang, Li, Luo & Li, 2022; Li, Ye, Dai, Zhai & Sheu, 2019; Ahmed, 2018). Nonetheless, all of these must be incorporated into the organisation's overarching strategy. Likewise, top management can only authorize the allocation and release of scarce resources. This includes setting clear goals and targets, providing resources and support, and creating a culture of sustainability and environmental conservation (Ram et al., 2023; Liang et al., 2022). Yuan, Zuo, and Huisingh (2013) suggest that successful implementation of GC initiatives requires support from all university stakeholders. Ram et al. (2023) argue that the drive to green IT begins with the passion of IT and business leaders for climate change and environmental sustainability.

Another factor is raising awareness among staff and students about the benefits of GC practices is critical for successful implementation. As indicated by Asabere et al. (2016), people are likely to implement Green ICT, when they are aware of the technology. Similarly, Apulu et al. (2016) stated that a lack of awareness hinders the acceptance and application of technology. Providing training and education on how to implement and use GC practices can help staff and students adopt them more easily.

Additionally, Yuan, Zuo, and Huisingh (2013) suggest that collaboration, awareness, engagement, and support among university stakeholders, including staff, students, alumni, and external partners' is vital for the effective implementation of GC practices (Owusu, 2023). This may require involving them in the planning, implementation, and monitoring of GC initiatives. Furthermore, policies and regulations have been cited as contributing factors that can provide a framework for the implementation of GC practices (Anthony & Majid, 2016; Subburaj, 2014). This includes setting targets for energy efficiency, sustainability, and environmental conservation and providing incentives or penalties for meeting or failing to meet these targets (Anthony & Majid, 2016).

Nonetheless, the implementation of GC practices requires appropriate technological infrastructure, including energy-efficient hardware, software, and systems (Uddin & Rahman, 2012; Molla & Cooper, 2008). These infrastructures should be compatible with existing systems that meet the needs of staff and students.

Lastly, the effectiveness of GC practices should be monitored and evaluated regularly. This includes tracking energy consumption, carbon footprint, cost savings, and other key performance indicators (Katal, Dahiya & Choudhury, 2023; Opoku et al., 2020). The results of monitoring and evaluation should be used to adjust GC initiatives to maximize their effectiveness.

As an example, Ashesi University through the installation of a "US-based energy efficiency analyzer, with weekly monitoring, measurement and reporting system" monitors the "trend of electricity consumption from the national grid, on-site owned diesel generators and renewable energy production" (Ashesi University, 2023).

2.1.8 Green Computing Implementations in Ghanaian HEIs

As emphasized earlier, HEIs in Ghana are organisations with non-IT products or services that use IT occasionally or use IT on some non-core business processes. This means that GC implementation can be approached from usage and disposal, as well as strategy and policy but not in design and manufacturing (Muladi & Surendro, 2014). To gain a comprehensive understanding of the specific GC implementations in HEIs required the review of academic literature, research papers, and reports focusing on sustainability efforts and IT practices in terms of computing usage, disposal, strategy, and policy.

According to the GTEC (2022), which has recently replaced the National Accreditation Board (NAB), there are ten (16) public universities and over a hundred (100) private universities spread across the sixteen (16) regions of Ghana. Among the 16 public universities are University of Ghana (UG), Kwame Nkrumah University of Science and Technology (KNUST), University for Development Studies, University of Cape Coast (UCC), University of Mines and Technology, University of Energy and Natural Resources (UNER), University of Professional Studies, Accra (UPSA) and University of Health and Allied Sciences (UHAS) (GTEC, 2022). Although E-learning has been in existence for decades (Mohabuth, 2022), particularly in Ghana, its adoption has been low, especially in KNUST and UCC (Kotoua, Iikan & Kilic, 2015), until recently when the Covid-19 pandemic emerged (Mohabuth, 2022; Hatsu & Asamoah, 2020).

According to Hatsu and Asamoah (2020), the outbreak of Covid-19 propelled the roll out and continuous use of e-learning platforms (Mohabuth, 2022; Mohabuth, 2022) by a signification number of colleges and universities in Ghana, when schools had to close down (Arhinful, 2020; BBC, 2020; Myjoyonline, 2020).

To ensure environmental sustainability and business continuity (Adjei et al., 2021; Opoku et al., 2020), HEIs in Ghana have employed the use of Electronic-learning (E-learning) platforms (Acheampong, 2022; Narh, Boateng, Afful-Dadzie & Owusu, 2019; Tawiah; Lamptey, Okyere, Oduro & Thompson, 2019), energy-efficient data center infrastructure, virtual technologies, thin-clients in their major computer labs. Strategies such as creating green awareness among the university community, turning off unused computing devices, and disabling screen savers have also been adopted (Opoku et al., 2020; Asabere et al., 2016). These GC implementations are aimed at reducing energy consumption and achieving cost savings through minor changes in how computers are used (Opoku et al., 2020; Nunoo, Mariwah & Suleman, 2019).

E-learning also known as online-learning (Ayu, 2020; Mayer, 2019) enables the delivery of education through various kinds of media such as audio, video, animation, and images through the internet (Mayer, 2019; Narh et al, 2019). E-learning platforms drastically reduce the need for campus utilities allowing learners and instructors to achieve their academic objectives regardless of their physical locations (Owusu, 2023; Mayer, 2019). Additionally, e-learning platforms enable lecturers and students to telecommute. As posited by Owusu (2023), telecommuting provides a significant method for tackling traffic congestion and pollution. Telecommuting also ensures minimal use of electricity, air conditioning, and lighting, saving universities huge sums of monies and reducing their carbon footprints in one way or the other (Owusu, 2023; Javid, 2022).

HEIs promote environmental sustainability by employing virtualization technology for servers and desktops (Mohabuth, 2022; Uddin et al., 2017). Virtual servers allow for the hosting of several services and applications on a single machine instead of multiple machines, thus reducing the power needed to run and cool physical servers (Uddin et al., 2017; Uddin and Rahman, 2012). In addition, HEIs employ Advanced Configuration and Power Interface (ACPI), an open industry standard that allows operating systems to control the power savings of their hardware. To optimize energy consumption, most universities in Ghana have adopted centralized power management solutions, including centralized air-conditioners and shared printers for easy management. Ashesi University advocates for and executes programs on renewable energy and energy efficiency that targets climate action, efficient resource utilization, and sustainable living practices (Ashesi University, 2024).

Furthermore, HEIs in Ghana have transitioned from paper-based activities to online-based activities, including the use of electronic mail (e-mail), learning and course management systems (Sakai, Moodle), and online assessments (examinations, lecturer and course evaluations) (Sarpong, Dwomoh, Boakye & Ofosua-Adjei, 2021; Ampofo, 2020; Owusu, 2020; Narh et al., 2019). Others included electronic pay-slips, online payment systems, student and staff portals (MIS web portals, STS, staff directory), and online applications (student admissions, leaves, and promotions) (University of Ghana, 2024; University of Cape Coast, 2023; KNUST, 2024). For example, most universities assign email addresses to students and staff as part of the on-boarding process for every newly admitted student or recruited staff. The universities encourage the use of email addresses by employing them as the main communication tool for all university correspondence. Course management systems (Sakai, Moodle) enable faculty members (instructors) to share electronic documents with students without handling HTML or other programming languages (Janssen, 2015).

Most universities in Ghana have adopted Moodle (KNUST, UPSA, Central University, Bluecrest, UEW, UCC) except for UG which has adopted the Sakai learning management system (LMS) since 2013 (University of Ghana, 2013). These online-based activities greatly reduce reliance on paper for numerous processes across the different university campuses thereby reducing the environmental impact of printing and promoting the sustainable use of the university resources (Sarpong et al., 2021).

HEIs in Ghana have resorted to procuring and purchasing electronic and computing appliances from environmentally committed companies that ensure compliance with the Environmental Protection Agency's (EPA) Energy Star guideline (Opoku et al., 2020). Energy-star rated gadgets and appliances consume less energy and are environmentally friendly. According to Opoku et al. (2020), an energy audit revealed that KNUST purchased and used energy-efficient LED lamps (18 Watt T8 fluorescent lamps, and 15–40 Watt LEDs) across many of their lighting systems.

HEIs in Ghana have taken environmentally friendly steps in-terms of recycling and disposal of old and unwanted computing equipment. As an example, KNUST in collaboration with German Development Cooperation (GIZ) supported Electro Recycling Ghana (ERG), an established electronic waste disposal company responsible for disposing of electronic waste (e-waste), including old computers, laptops, and other IT equipment (Daily guide, 2023). Collaborating with certified e-waste recycling organisations ensures that the electronic waste of the university is properly handled and recycled.

In addition, most universities in Ghana run curricula in environment and sanitation programs for both undergraduate and postgraduate degrees. For example, UG's Institute for Environment and Sanitation Studies (IESS) runs graduate programs geared towards training and raising experts with deep knowledge and solutions to address the growing crisis of e-waste.

Lastly, most HEIs in Ghana as part of their corporate strategy and policies have incorporated guidelines on environmental sustainability (KNUST, 2023; Ashesi University, 2023; UCC, 2022). As an example, KNUST's energy and procurement policies stress cost-effectiveness and the reduction of the negative environmental impact of its energy and procurement activities (KNUST, 2023). UG's ICT procurement policy captures guidelines on purchasing ICT equipment according to specification and approval by the University of Ghana Computing Systems (UGCS) (University of Ghana, 2023). Ashesi University, as part of its policy element and strategies, has a designated sustainability administrator responsible for the implementation of sustainability attainment programs. This role includes "sensitization and awareness communication" and ensuring that the environmental policy is published in an accessible format for staff and students, thereby promoting sustainability principles within the university community (Ashesi University, 2023).

2.1.9 GC Implementations and Competitive Advantage of Ghanaian HEIs

It is evident that green initiatives present some form of advantage to the adopting organisations (Borsatto & Amui, Tu & Wu, 2021; 2019; Yin et al., 2020; Singjai et al., 2018; Fraj et al., 2015). Within the education sector, several literatures have provided evidence to support these assertions (Purwanti, 2022; Atici et al., 2021; Bansal & Khan, 2019; Blok et al., 2015). In developed countries, such as America and the UK, several universities have demonstrated innovation and leadership in sustainability and GC efforts, specifically, Binghamton University, Cornell University, Georgia Institute of Technology, and Harvard University (Agarwal et al., 2012).

In Ghana, universities can reduce their environmental impacts through GC initiatives. For instance, implementing e-learning, server virtualization, thin-client computers, using energy star-rated appliances, and transitioning to energy-saving bulbs can significantly decrease energy usage (Opoku et al., 2020; Mithas et al., 2010).

The savings from these initiatives can bolster revenues, that when channeled into other ventures could give a competitive advantage to these universities (Mithas et al., 2010).

In an era where university rankings based on sustainability have gained significant attention (Ragazzi & Ghidini, 2017), it has become crucial for HEIs worldwide to secure a spot on the renowned University of Indonesia (UI) Green Metric World University ranking to demonstrate their commitment to environmental sustainability (Atici et al., 2021). UI Green Metric World University ranking evaluates universities based on green and sustainability practices, economic and equality principles (Purwanti, 2022). The recognition and reputation gained from such rankings confer a competitive advantage to the universities listed. As explained by Christensen and Gornitzka (2017), university rankings put significant pressure on universities compelling them to adhere to established and acceptable green standards and policies. Therefore, Ghanaian HEIs must capitalize on GC implementations to enhance their chances of inclusion in these influential rankings.

2.2 Related Studies on GC Implementation

This section of the research presented a detailed review of related studies regarding GC adoption and implementation in HEIs to gain a deeper understanding and identify gaps for future studies. Boateng (2014) stated that the articles reviewed by a researcher help in resolving unanswered questions, bridging research gaps, establishing the foundation for a study's topic, and justifying the selected research methodology. The literature review was conducted following the classification and analytical framework proposed by Boateng (2014) and Molla and Heeks (2009), which includes categorization of the literature, identification of the primary focus of the studies, theories or models applied, methodological approaches adopted, contexts of the research, and identification of existing research gaps.

This structured approach allowed for a comprehensive and systematic examination of the literature in the field ensuring a thorough understanding of the current state of knowledge and highlighting areas requiring further research.

In the same vein, Ribeiro et al. (2021) categorized GC research into three phases, namely pre-adoption, adoption, and post-adoption. Table 2.4 provides a summary of selected GC studies based on pre-adoption, adoption, and post-adoption research categories.

Table 2.4: Summary of Studies on Green Computing

Author(s)	Study focus	Theory/Framework	Research Method and Context	Identified Gaps for Future Research
Literature on Pre-Adoption				
Thomson and Van Belle (2015)	To investigate the antecedents for the adoption of Green IT in South African Higher education institutions (HEI)	Conceptual model- GITAM (Green IT Adoption Model) developed by Molla (2008)	Quantitative South Africa	Need for further studies for an international comparison to see which factors and relationships are dependent on country, regional, and developing economy contexts
Freeman (2016)	Assessment of green computing practice among tertiary institutions in Ghana	No theory/Model used	Mixed Ghana	Authors recommended further studies that delve into awareness and knowledge of diverse computer user populations to

				provide baseline data for green initiatives in Ghana.
Ahmed (2018)	To understand the factors affecting the adoption of Green Computing in the Gulf Universities	TOE framework	Quantitative Gulf States	The need to investigate new factors that affect the adoption of GC, particularly in an environmental context; for example, the influence of donors and international organisation on GC adoption in developing countries
Oyo et al. (2019)	To determine green belief and attitude among Information Technology professionals	Belief-Action-Outcome (BAO) framework	Quantitative Malaysia	The need for subsequent research to investigate the multilevel relationships among underlying micro and macro factors of the individual GIT beliefs, attitude, and

				practices to ensure the explanation of the effects of
Lasrado and Zakaria (2019)	To explore organisational factors that influence self-initiated green behavior in the United Arab Emirates	Behaviour Change Wheel	Qualitative United Arab Emirates	The need to test a theoretical model for instilling green behavior in the workplace by using a quantitative method to provide support to the rich understanding of the green behaviors
Wabwoba et al. (2013)	To develop Green ICT Readiness Model for Developing Economies: Case of Kenya	Conceptual model-GITAM	Quantitative Kenya	Future studies recommended to be conducted to establish ICT personnel capabilities on green ICT readiness.

Literature on Adoption				
Mbewe (2019)	Assessment of Green Computing Awareness and Adoption in Higher Education Institutions in Zambia	Theory of planned behaviour	Quantitative Zambia	The need for further studies in difference geographical areas
Hanief et al. (2019)	To Propose a Model of Green Computing Adoption in Indonesian Higher Education	Conceptual model	Quantitative Indonesia	Further studies needed to evaluate and improve the model using more data from other universities through additional hypothesis and CFA (quantitative methods)
Asadi et al. (2015)	Theoretical Model for Green IT Adoption- IT	Theory of Planned Behavior (TPB) and	Quantitative Malaysia	For future work, more data needs to be collected from different sectors in other countries to test the model

	managers of Malaysian organisation	Norm Activation Theory (NAT)		
Gholami et al. (2013)	To assess Senior Managers' Perception on Green IS adoption and environmental performance	Belief-Action-Outcome framework	Quantitative Malaysia	The need for the study to be conducted using firms in other countries
Mouakket and Aboelmaged (2022)	To understand the drivers and outcomes of Green IT adoption in Service Organisations with focus on emerging economy context	TOE framework	Quantitative United Arab Emirates (UAE)	The need for other studies to be conducted using firms in other countries

Literature on Post Adoption				
Sayeed et al. (2009)	To explore the implementation of Green IT measures from the perspective of the dynamic resources in organisations	Dynamic Capabilities	Qualitative	Recommendation for further studies using large sample from multiple industries and quantitative data analysis
Asabere et. al. (2016)	To understand the strategies of Green ICT Implementation in Polytechnic Education in Ghana	Technology Acceptance Model (TAM), Technology Acceptance Model 2 (TAM 2)	Not specified Ghana	The need for others studies to be conducted in other universities to generalize the findings

Butler and Hackney (2012)	Breaking the Iron Law: Implementing Cost Effective Green ICT in the UK Public Sector	Institutional Theory	Quantitative United Kingdom	The need for other studies to be conducted using firms in other countries
Mithas et al. (2010)	Green Information Technology, Energy Efficiency, and Profits: Evidence from an Emerging Economy	Belief-Action-Outcome Theory (BAO)	Archival/Secondary data	First, future studies might look at objective firm and industry level data on performance influence due to green IT. Second, future research should consider the lifecycle approaches to assess the impact of green IT initiatives.
Ribeiro et al. (2021)	To understand the adoption phases of Green Information Technology in enhanced	No theory/Model used	Literature Review	Future research on GIT could focus on exploring avenues identified under the present study's discussion topics and new clusters of discussion not detected in the proposed portfolio categorization.

	sustainability			
Other literature: Green Computing for Competitive Advantage				
Rahim and Rahman (2013)	Applicability of resource-based environmental studies in Green IT	Resource-Based View (RBV)	Literature Review	To contribute to the applicability of RBV in Green IT concept, there is the need to study the moderating variables that can enhance Green IT implementation and practices
Loeser et al. (2011)	Aligning green IT with environmental strategies: Development of a conceptual framework that leverages sustainability and firm competitiveness	Conceptual (Resource-Based View (RBV))	Unknown	The need for the conceptual framework to be tested, refined and verified in other case study research

Rahman et al. (2014)	Green IT for Competitive Advantage: Internal Management Perspective	Natural Resources Based View	Quantitative	The need for future studies in other industries (aside IT companies) in different countries

Source: Author's construction

2.2.1 Conceptual Approaches in Green Computing Implementation Research

This aspect of the study discusses the conceptual approaches used in GC research in the reviewed literature. According to the literature reviewed in Table 2.2, most of the studies on GC used diverse theories in understanding the concept of GC. In the pre-adoption phase, that is readiness, understanding the determinants or factors of the adoption and benefits, Green IT Adoption Model (GITAM) developed by Molla (2008), BAO and TOE framework developed by Melville (2010) and DePietro et al. (1990) respectively were used. However, BAO and TOE were used extensively in all three phases of GC adoption.

Furthermore, most studies used the RBV, including the natural RBV, as theoretical frameworks to investigate the applicability of RBV in GC concept to understand how rare and non-imitable resources of firms give sustained competitive advantage.

2.2.2 Research Gaps and Future Research Directions

In this study, several articles on GC implementation have been reviewed to demonstrate understanding of the concept. However, the available body of knowledge on GC adoption and implementation in HEIs is without gaps and calls for direction for future studies in terms of context, issue, and theories.

Globally, the concept of GC in the education sector has been studied extensively in the literature (Hedman & Henningsson, 2011; Kevin et al., 2015; Lasrado & Zakaria, 2020; Loke et al., 2014; Molla & Cooper, 2008; Murugesan, 2008; Subburaj, 2014; Wabwoba et al., 2013).

In the education sector, studies on GC have focused primarily on determinants for adoption, awareness, and knowledge levels (Ahmed, 2018; Thomson & Van Belle, 2015; Freeman, 2016; Mbewe, 2019). In Zambia, Mbewe (2019) conducted a study to check the level of awareness and adoption of GC in HEIs in Zambia. It was identified that GC awareness level was simply moderate and the level of GC adoption was low.

In a study conducted by Ahmed (2018), the researcher studied the key factors influencing the adoption of GC in universities across the Gulf region. The study identified the top five success factors for GC adoption in these institutions as awareness, relative advantage, top management support, adequate resources, and government policy.

In Ghana, studies have focused primarily on GC adoption, practices, development of a sustainable GC model for computer users, and strategies for GC implementation. Freeman (2016) assessed the current state of GC adoption and practices in HEIs and came up with a sustainable conceptual model for computer users. Asabere et al. (2016) outlined possible green ICT implementation strategies in polytechnic education in Ghana. Again, Asabere et al. (2016) studied the importance of GC awareness and acceptance in building the capacity of ICT personnel essential for Green ICT implementation. Despite the increasing research popularity and benefits of GC, there is little evidence of studies measuring or assessing GC implementation effectiveness in both developed and developing economies. As evident in Table 2.2, on the post-adoption phase of GC, none of the studies captured or measured the effectiveness of GC implementation.

Additionally, several studies on GC concept have been done through conceptual models (Molla & Cooper, 2008; Thomson & Van Belle, 2008; Wabwoba et al., 2013; Hanief et al., 2019) as seen in Table 2.2, and others without theoretical underpinning (Asabere et al., 2016). Furthermore, several researchers have emphasized the need for studies in the area of dynamic resources (Eisenhardt & Martin, 2000; Teece et al., 1997). However, little of such research has been conducted in response. The literature reviewed indicated that the RBT is one of the most widely used theories for firm performance (Barney et al., 2011, Kraaijenbrink et al., 2010, p.350; Wang et al., 2015). Therefore, it was important to study the effectiveness of GC implementation in HEIs using RBT and DC as theoretical lenses. These identified context, issue, and theory gaps justify the future direction of this study.

2.3 Chapter Summary

The chapter reviewed the literature on GC concept in general. It also looked at GC adoption and implementation in both developed and developing countries context. In summary, the chapter provided an overview of the literature that relates to GC including definitions, approaches to its application, dimensions, implementation strategies, benefits, challenges, and factors for GC implementation success, and finally, a detailed look at GC implementation in HEIs in Ghana. The literature review led to the identification of gaps for future studies that informed the purpose of this study.

CHAPTER THREE

THEORETICAL FRAMEWORK

3.1 Chapter Overview

The preceding chapter primarily focused on defining GC concept and a review of literature on the concept that led to the identification of gaps that informed the selection and justification for this study. This chapter discussed literature relating to the chosen theories towards arriving at a conceptual framework of how HEIs implement effective GC by using the unique resources available to them. The research frameworks considered appropriate to achieve the objectives of the study and answer the research questions are the RBV and the DC theories.

This chapter provided an overview of the RBV and DC theories, a justification of the selected theories, and some use of the theories in existing research, followed by an explanation of the constructs of the theories. The chapter included a conceptualization of the theories and the formulation of hypotheses based on the review of literature that used the above theories. A summary of the discussions in this chapter concludes the chapter.

3.2 Overview of the Resource-Based View Theory

RBV also known as Resource-Based theory (RBT), developed by Barney (1991) is one of the most used firm-level theories that explain performance outcomes, predicting competitive advantage (Barney, Ketchen & Wright, 2021; Kariuki & Nguyo, 2020; Miller, 2019) and why some firms are more profitable than others (Mataruka, 2022; Baia, Ferreira, & Rodrigues, 2020). According to Barney et al. (2021), RBT explains that firms can achieve sustainable competitive advantage through obtaining and controlling internal “valuable”, “rare”, “inimitable” and “non-substitutable” (VRIN) resources and capabilities (Singh, 2022; Miller, 2019; Barney, 1991). Budu (2013) claimed that firms use their unique resource to create mobile-services (m-services).

As such, it was important to explore the resources used for the successful creation of these m-services, as it was impossible to create m-services without these resources. Budu (2013) further stated that these resources are better identified by RBT. The main argument of the RBT is that firms who control scarce resources are more profitable than those who do not and that such firms can make superior returns as compared to the other firms in the same sector giving them a competitive advantage (Matatuka, 2022; Baia et al., 2020; Seddon, 2014). According to Matatuka (2022), RBT serves as resilient theoretical grounds for arguing that, investments in IT are a vital source of competitive advantage and firm performance. The use of RBT for this study is justified, in that; it helps identify the unique resources of HEIs that help in effective GC implementations in Ghanaian universities. RBT consists of three independent constructs including resources, assets, capabilities, and dependent constructs including competitive advantage, organisational performance, and rents (Barney et al., 2011; Barney, 1997; Barney 2001).

3.2.1 Constructs of the Resource-Based Theory (RBT)

The constructs of RBT defined by Barney (1991) are described in subsections (3.2.1.1 to 3.2.1.3).

3.2.1.1 Resources

Wade and Hulland (2004, p. 109) defined resources as the "assets and capabilities that are available and useful in detecting and responding to market opportunities". According to Singh (2022), resources form the foundation and basis of a firm's capabilities. Researchers postulate that firms' resources can be acquired on the market (Gellweiler, 2018) and could be financial, legal, technological capital, human capital, relational or informational that are heterogeneously distributed among organisations in the same sector (Miller, 2019; Landroguez, Castro, & Cepeda-Carrión, 2011).

The onus lies on the managers of these firms to organize these resources for sustainable competitive advantage (Ram et al, 2023; Ahmed, 2018; Barney, 2011).

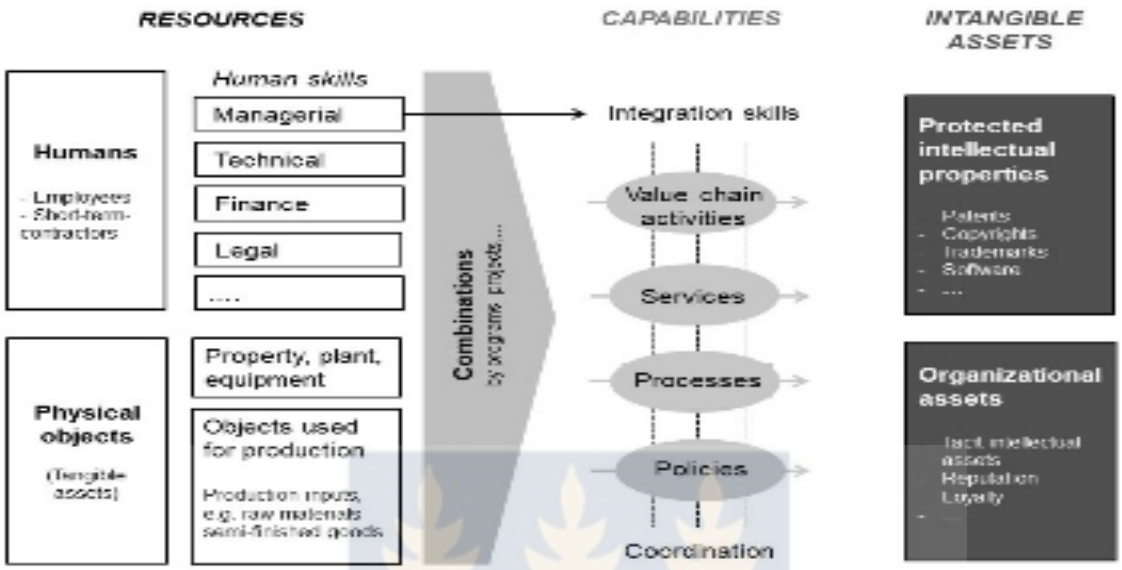
3.2.1.2 Capabilities

Capabilities on the other hand, as explained by Wade and Hulland (2004, p. 109), are "repeatable patterns of actions in the use of assets to create, produce and or offer products to a market". Various researchers have explained capabilities as "skill" (Helfat et al., 2017), "know-how" (Barney & Hesterly, 2019), and as what an organisation "does" as opposed to what it "has" (Razak et al., 2023). According to Gellweiler (2018), whereas resources can be acquired from the market, capabilities need to be developed from the available resources in the organisation. As RBT posits, capabilities could be a source of competitive advantage, however, such advantage is not sustainable unless organisational resources are re-combined to continuously create value (Chavez et al., 2017).

3.2.1.3 Assets

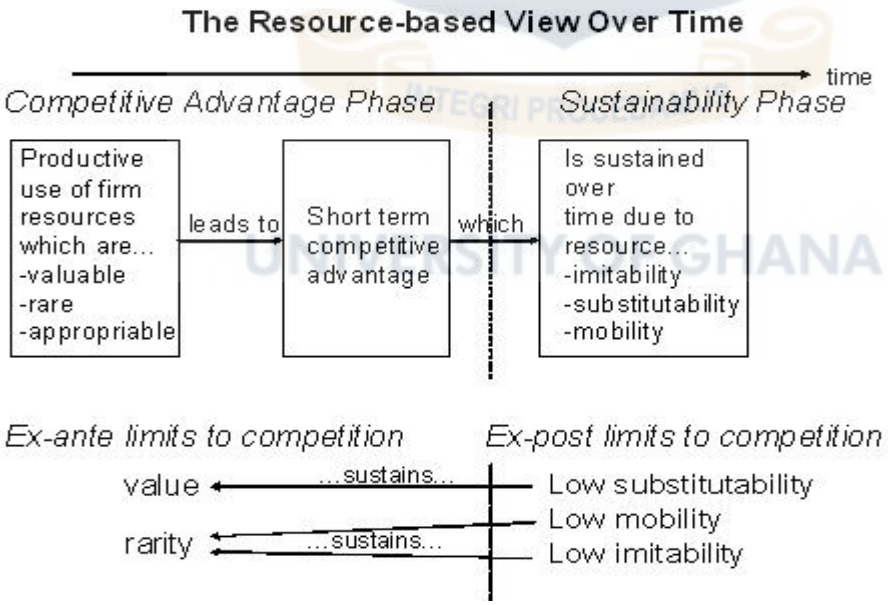
Wade and Hulland (2004, p. 109) define assets as "anything tangible or intangible firms use in its processes to create, produce, and/or offer its products (goods or services) to a market" and are classified into "tangible and intangible" (Sayeed et al., 2009). Tangible assets are fixed or physical resources that can be seen, touched, and quantified and include technological (IS hardware, network infrastructure), financial, structural, equipment, and property (Gellweiler, 2018; Wade & Hulland, 2004, p. 109). Intangible assets are non-physical that are more difficult to quantify including markets, brand-reputation, intellectual property rights, patents, copyrights, trademarks, confidential documents, and software (Gellweiler, 2018; Kamasak, 2017, p. 261; Wade & Hulland, 2004, p. 109). Figure 3.1 and Figure 3.2 describe the resources, capabilities, and assets as used in the Resource based-theory.

Figure 3.1: Resources, Capabilities and Assets



Source: Adopted from Gellweiler (2018)

Figure 3.2 Schematic Diagram of Resource-Based Theory



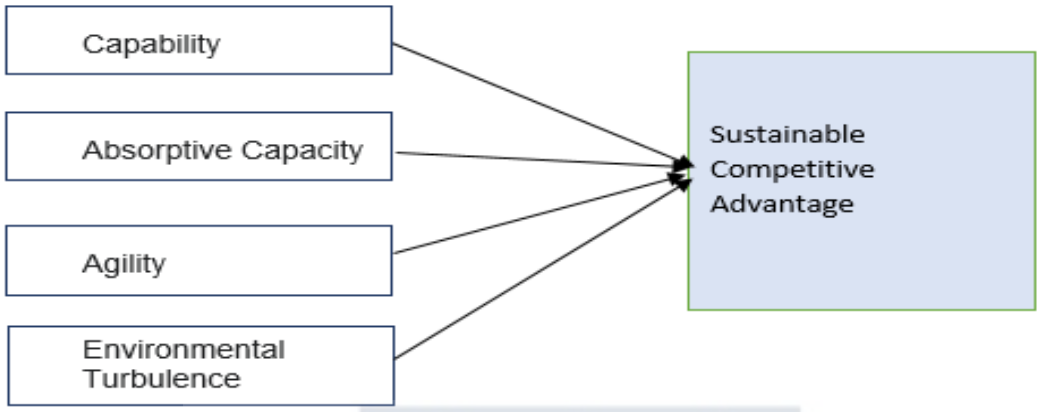
Source: Adopted from Wade and Hulland (2004)

3.3 Overview of the Dynamic Capabilities (DC)

DC is an extension of the RBT (Singh, 2020). RBT has faced criticism for its inability to account for how certain firms maintain competitive advantage amidst rapid technological advancements and volatile environmental changes (Arthur, Anku-Tsede, Sanda & Belfiore, 2022; Matatuka, 2022; Singh, 2020) because RBT assumes a static nature, that resources are heterogeneous across all firms over time (Altintas, 2019; Ashrafi & Mueller, 2015). In other words, RBT focuses on the resources internal to a firm per se and ignores the environmental factors or world outside (Matatuka, 2022; Gellweiler, 2018; Ridge el al., 2014). This called for the DC to explain firms' competitive advantage over time in their rapidly changing environments (Ridge el al., 2014). According to Singh (2020), dynamic capabilities are those processes that enable organisation to sustain superior performance over time. In the same vein, Teece et al. (1997, p. 516) maintained that a firm's capability to "integrate, build, and reconfigure internal and external competencies" is significant to gaining competitive advantage in a rapidly technological changing environment. As opined by Christensen and Overdorf (2000), GC presents a disruptive technological change to organisation (Mohabuth, 2022). Therefore, in the context of GC implementation in HEIs, it is justifiable to use DC theory.

Dynamic Capabilities theory consists of four independent constructs and one dependent construct. These constructs include Capabilities, Absorptive capacity, Environmental turbulence, Agility, and sustainable competitive advantage (Teece et al., 1997).

Figure 3.3: Schematic Diagram of Dynamic Capabilities Theory



Source: Author's construction (Adapted from Teece et al., 1997)

3.3.1 Constructs of the Dynamic Capabilities Theory

The constructs of DC theory defined by Barney (1991) are briefly described in subsections (3.3.1.1 to 3.3.1.4).

3.3.1.1 Capabilities

Ferreira et al. (2020, p. 92) define dynamic capabilities as *"the potential to systematically solve problems, enabled by its propensity to sense opportunities and threats, to make timely and market-oriented decisions, and to change its resource base*". In addition, Helfat and Raubitschek (2018) define capabilities as abilities or skills that a firm has that enable it to intentionally create, expand, or alter its resources, thus allowing it to execute specific activities or tasks more effectively than its competitors. On the other hand, Barney and Hesterly (2019) defined capabilities as what an organisation can do based on the resources it possesses. In this context, capabilities refer to the ability of HEIs to effectively implement GC practices, such as the knowledge and skills, required to deploy and manage energy-efficient hardware and software, optimize data center operations, and implement policies and procedures for

sustainable computing. Ferreira et al. (2020) explained that a firm with a good capability has the potential to exploit market opportunities. Examples of capabilities, as cited by Wade and Hulland (2004, p. 109) are "technical skills, managerial skill, system development or systems implementation"

3.3.1.2 Absorptive capacity (AC)

AC as defined by Cohen and Levinthal (1990) refers to a firm's ability to recognize, assimilate, and apply new external knowledge to improve its performance. Lane et al. (2006) share similar views with Cohen and Levinthal (1990) but further elaborated that recognizing and utilizing knowledge involves a series of processes, including "exploratory learning", "transformational learning", and "developmental learning". Other researchers, Zahra and George (2002) posit that AC is a dynamic ability that helps firms achieve and sustain a competitive edge by creating and utilizing knowledge. In this context, AC refers to HEIs ability to learn from its experiences and external sources of knowledge and to integrate new knowledge into its existing practices including the ability to access and use information from external sources, such as research and development, government policies, and industry best practices.

3.3.1.3 Environmental Turbulence (ET)

ET as "the degree of change in technology, customer demand, and market competition intensity in an industry" Song et al. (2021, p.4). In this context, ET refers to the external factors that can affect the institution's GC initiatives, such as changes in government policies, market forces, or social and cultural norms. Zhou et al. (2019) stated that two major dimensions of ET; namely market and technological turbulence (Song et al., 2021). Zhou et al. (2021) further explained that market turbulence is changes that occur on the demand side, whereas technology turbulence changes happen on the supply side. Market turbulence Technological turbulence, on the other hand, reflects the degree of changes in a firm's technology (Song et al., 2021; Zhou et al., 2019).

3.3.1.4 Agility (A)

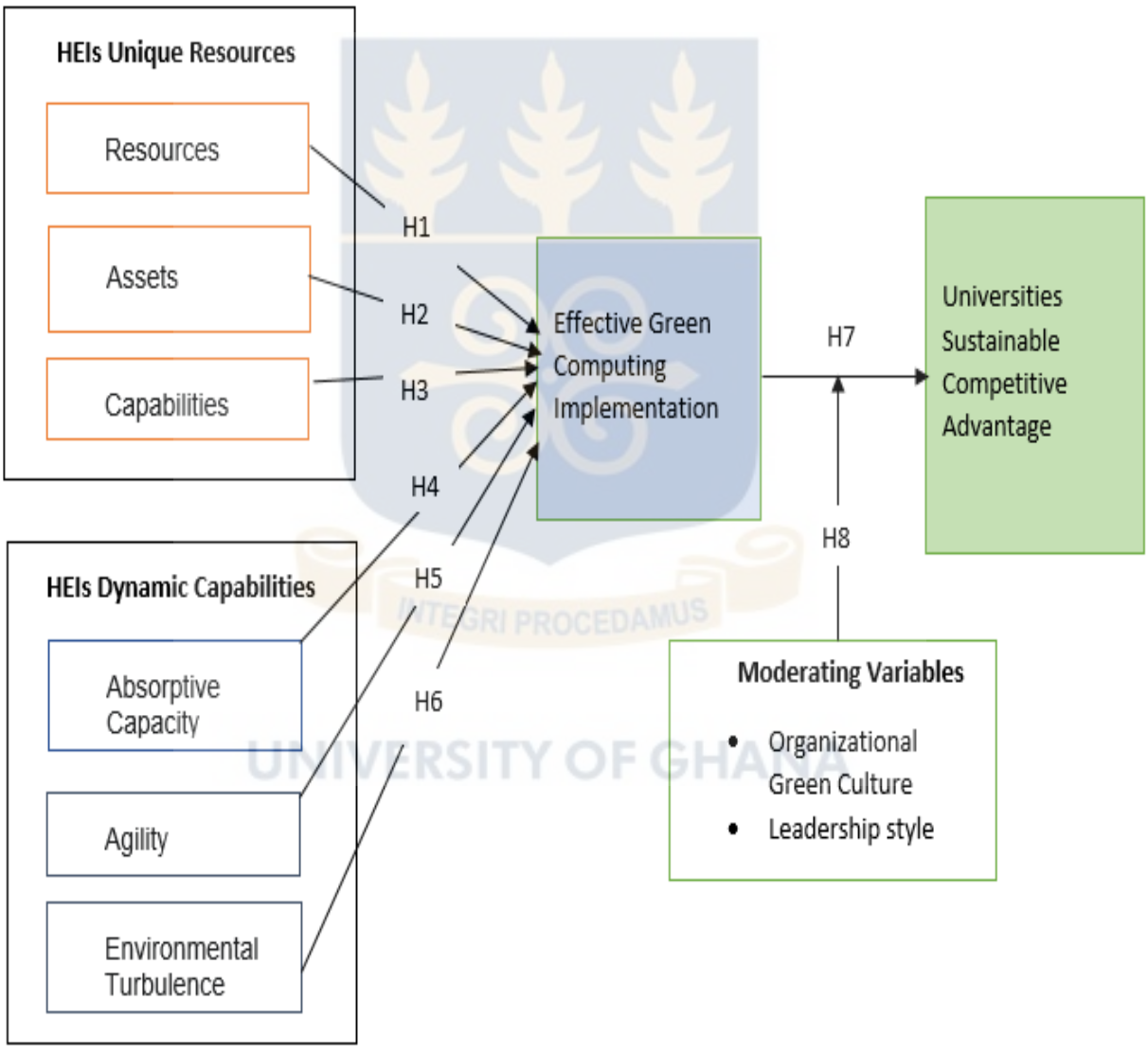
As defined by Rick Dove (1992), agility refers to a firm's ability to adapt quickly to changes or unpredictability in the environment. In this context, Agility refers to the ability of HEIs to respond quickly and adaptively to changing circumstances and emerging challenges, such as changes in technology, regulatory requirements, or stakeholder expectations.

3.4 Research Framework

Based on the overview of Resource-Based Theory (RBT) and Dynamic Capabilities (DC), a conceptual framework was developed. RBT has come to dominate theoretical frameworks in firms' growth and performance (Teece, 2014). As such, it is appropriate for use to assess the performance of GC implementations. However, it assumes that for a firm to create and sustain performance and competitive advantage, the resources must be heterogeneous and immobile. Nonetheless, in the case of HEIs in the digital world, resources keep changing rapidly. Therefore, the DC theory was also vital for this study to compliment RBT (Mataruka, 2022). A combination of the two theories enabled the study to broadly assess the factors that contribute to effective GC implementations and sustainable competitive advantage in HEIs. Furthermore, organisational culture and leadership style have been included in the conceptual framework as moderating factors to investigate how these influence the relationship between effective GC implementations and sustained competitive advantage in HEIs. Several studies have suggested that the culture and leadership style adopted in an organisation have a significant impact on the adoption and implementation of technology (Abbas & Khan, 2023; Tortorella, Fettermann et al., 2021; Owusu et al., 2020). Specifically, Abbas and Khan (2023) admonished that green culture is a vital resource for understanding the connection between green knowledge management, green performance, and innovation.

Others have also over-emphasized the influence of culture and the style adopted by top management on the future green success or competitiveness of the organisation (Muisyo et al., 2022; Banini, Lim & Anosike, 2021). It was, therefore, necessary to ascertain the extent to which these factors moderate the correlation between effective GC implementation and Universities' sustained competitive advantage.

Figure 3.4 Conceptual framework for Effective Green Computing Implementation



Source: Author's construction

3.5 Hypothesis Development

3.5.1 Independent Variables (IV)

3.5.1.1 Resources

Wade and Hulland (2004, p. 109), defined resources as "available assets and capabilities useful in detecting market opportunities". Budu (2013) supports this claim by referring to resources as assets and capabilities in his study. Adequate resources, including funding, personnel, technology and physical assets, patents, trademarks, information, and knowledge (Chen et al., 2019; Daft, 2015) are necessary for successful GC implementation. According to Nason and Wiklund (2015), firms aim to control resources that allow them to capture associated rents, safeguard those resources from external threats, and foster competition with others in the same market place. Kraja (2018) agrees with Nason and Wiklund's (2015) claim that available resources with their special characteristics are sources for creating distinctive skills for organisational growth. Other researchers have argued that firms' resources can be ordinary and still serve as a competitive tool (Asharaf & Mueller, 2015; Bozic & Dimovksi, 2019) and that the ability to combine ordinary resources makes a firm unique to achieve greater performance and competitive advantage (Asadi et al., 2021; Bozic & Dimovksi, 2019; Fairhangh et al., 2012). However, Mataruka (2022) disagreed; and found that resources though required are not sufficient to achieve greater firm performance and competitive advantage. Nason and Wiklund (2015) identified that versatile resources have a stronger effect on growth than non-versatile resources; Gitobu and Njoroge (2015) asserted that firms can be efficient and achieve their objectives by engaging in green practices using limited resources to meet customer needs. Therefore, it can be hypothesized that:

H1: HEIs resources positively influence effective GC implementation

3.5.1.2 Assets

Assets refer to "anything the firm uses in its processes to create, produce, and/or offer its products (goods or services) to a market" (Wade & Hulland, 2004, p. 109). Sayeed et al (2009) identified two types of assets, tangible and intangible assets. Tangible assets are fixed assets that can be seen, touched, and quantified and include technological, financial, structural, and institutional resources (Wernerfelf, 1989; p. 7). Intangible assets are non-physical that are more difficult to quantify including markets, brand reputation, and intellectual property (Kamasak, 2017, p. 261; Gellweiler, 2018). Renowned scholars have emphasized that intangible assets are increasingly important for firm growth, value creation, and competitiveness (Haskel & Westlake, 2022; Cucculelli & Bettinelli, 2015). According to Fahy (2002b), intangible assets are important in creating value and gaining competitive advantage, as they are less likely to be duplicated since laws protect intangible assets such as intellectual property and copyright (Gellweiler, 2018). However, tangible assets like HEI buildings are relatively weak at preventing duplication by competitors (Barney, 1991). Kraja (2018) found that intangible assets have a greater impact on SME's success than tangible assets. As posited by RBT, tangible assets could be a source of competitive advantage; however, such advantage is not sustainable unless organisational resources are re-combined to continuously create value (Landroguez et al., 2011). Based on the above discussion, it can be hypothesized that:

H2: HEIs intangible assets positively influence effective GC implementation

3.5.1.3 Capabilities

As discussed in this chapter, capabilities are skills that a firm possesses to "purposefully create, extend or modify its resource base" allowing it to perform a particular activity or task at a superior level compared to its competitors (Helfat et al., 2009, p. 4). Parida et al., (2016) conceptualized dynamic capabilities as a superior level of capability, consisting of different sub-capabilities including absorptive, adaptive, network, and innovation capabilities. HEIs with strong capabilities in areas such as technology adoption, and sustainability management can be more effective at implementing GC practices. For instance, they may be better able to develop and adapt sustainable technologies and processes, conduct research on sustainability issues, and train staff and students in sustainable practices. Bharadwaj (2000, p. 186) argued that firms with superior IT capabilities achieve better financial outcomes than those with lesser IT capabilities which enables them to achieve and sustain greater performance. Likewise, in a study conducted by Weill and Ross (2004), they established that effective IT governance, a resource capability is a source of competitive advantage. Carr (2004, p. 6-7) argued that IT alone cannot give competitive advantage as it has been commoditized, as such, Galliers (2011, p. 329) admonished that an organisation's capability and competencies to put a commoditized IT or ICT to good use is crucial and plays a role in strategically positioning the firm over its competitors. This, O'Reilly and Tushman (2008) termed as "ambidexterity" of an organisation and explained the term as the ability to take advantage of new opportunities and exploit capabilities and new technological advancements. Parida et al. (2016) also suggested that ICT capabilities are important enablers to the performance and competitive advantage of a firm.

Based on the above discussions and review of literature, it is hypothesized that:

H3: HEIs capabilities positively influence effective GC implementation

3.5.1.4 Absorptive Capacity (AC)

AC is defined as "a firm's ability to utilize its dynamic capacity process to acquire, digest, and transform new external technologies and knowledge and finally integrate and apply them to commercial output (Song et al. 2021, p.4). Cohen and Levinthal (1990, p. 128) were the first to define AC as a firm's ability to identify, integrate, and use new external knowledge to enhance its performance. Song et al. (2021, p.4). According to Lane et al. (2006, p. 856), AC is associated with three key aspects of learning, "exploratory, transformative, and exploitative learning". Exploratory learning involves a firm's ability to interact with its external environment (Lane et al., 2006, p. 856). Transformative involves integrating new knowledge with existing knowledge, which allows the latter to be applied in new and innovative ways (Lane et al., 2006, p. 855). As argued by Lane et al. (2006), these aspects of learning enable firms with AC to learn from best practices and innovations in other organisations and industries and apply them to their context. Several researchers have underscored that firms' survival and continuity largely depend on their ability to acquire new information (AC) needed for business innovation and competitive advantage (Song et al.; 2021, Khan et al., 2020; Leiponen & Helfat, 2010). Cohen and Levinthal (1990) stated that firms with high AC are more likely to easily use external knowledge internally for commercial purposes, thereby enhancing learning effectiveness and innovation ability. Additionally, Khan et al. (2020) established that AC positively moderates the direct effect of social capital on a firm's strategic renewal. Furthermore, Volberda et al. (2010) posit that ensuring long-term survival and success is highly dependent on an organisation's ability to develop and maintain absorptive capability. This implies that HEIs with high AC, or the ability to acquire, assimilate, and apply knowledge and technology from external sources, may be more effective at implementing GC practices. Based on these discussions, it can be hypothesized that:

H4: HEIs Absorptive capacity positively influences effective GC implementation

3.5.1.5 Agility

Teece et al. (2016, p. 17) defined agility as "an organisation's capacity to efficiently and effectively redeploy or redirect its resources to value-creating and value-protecting higher-yields activities as internal and external circumstances warrant". Khan et al (2021) argued that strategic agility, a dynamic capability that enables firms to proactively respond and adapt to changes in an uncertain environment is dependent on the firm's social capital. This implies that the ability of HEIs to respond quickly and flexibly to changes in the sustainability landscape is crucial for effective GC implementation.

Several researchers have advocated for the use of IT infrastructure and digital transformation to enhance an organisation's agility (Birkinshaw; 2018; Rigby et al., 2016). Specifically, Sambamurthy et al. (2003) proposed building three interrelated capacities in the area of "operational agility", "customer agility" and "partnering agility" is needed to enhance an organisation's financial performance. The above implies that HEIs that are agile can adapt to changing regulations, technology advancements, and stakeholder demands and incorporate them into their sustainability strategy (Giesenbauer & Müller-Christ, 2020). They can also be proactive in identifying and addressing sustainability challenges and opportunities (Aleixo, Azeiteiro & Leal, 2018). In a study conducted by Nurjaman et al. (2021), it was established that strategic agility implementation improves firms' performance. Therefore, it can be hypothesized that:

H5: HEIs Agility positively influences effective GC implementation

3.5.1.6 Environmental Turbulence (ET)

Dess and Davis (1984) defined ET as the level of uncertainty and change in the external environment faced by firms over a certain period. Song et al. (2021, p.4), refer to ET as "the degree of change in technology, customer demand, and market competition intensity in an industry". As identified by Song et al. (2021), the external environment affects the implementation and results of a firm's strategy, in this context, GC implementation. Zhou et al. (2019) stated that two major dimensions of ET; namely market and technological turbulence (Song et al., 2021) challenge the initiation and implementation of green management practices. They further established that market turbulence weakens managerial innovation on green management and implementation. The reason cited is market turbulence induces uncertainty in demand and shifts in preferences, distracting the attention of top management from utilizing limited firms' resources for the successful implementation of green management and innovations (Zhou et al., 2019).

Technological turbulence, on the other hand, reflects the degree of changes in a firm's technology (Zhou et al., 2019; Song et al., 2021). Cassiman and Veugelers (2006) found that higher ET forces firms to acquire and absorb additional resources to enhance their innovation performance. Based on the discussions, it can be hypothesized that:

H6: High ET negatively influences effective GC implementation in HEIs

3.5.2 Mediating Variable

3.5.2.1 Effective Green Computing Implementation

Effectiveness refers to the extent to which something successfully achieves the desired outcome *(*Woinaroschy, 2022, p. 2*)*. According to Meeus and Oerlemans (2002), implementation effectiveness refers to the consistency, acceptance, and quality of targeted organisational members' use of a specific innovation. In this study, effective GC implementation is used as the DV for the unique resources and capabilities accounting for effective GC implementation in HEIs but as an IV for the main DV (Universities Sustained Competitive Advantage) in the conceptual model. According to Setiadi et al. (2018), GC implementation has a positive correlation with competitive advantage in the education industry. Their finding was in line with a previous study by Dao, Langella, and Carbo (2011) which presupposed that GC implementation could influence the value of competitive advantage. Therefore, it can be hypothesized that:

H7: Effective GC implementation positively influences universities' sustained competitive advantage

3.5.3 Moderating Variables

3.5.3.1 Organisational Green culture (OGC)

Muisyo and Qin (2021) defined culture as the internal components of organisations, whereas Lee et al. (2022) defined OGC as a collection of artifacts, assumptions, and values that represent a firm's efforts to promote environmental sustainability in its operations. OGC helps employees in developing pro-environmental behaviors within an organisation by shaping their green behaviors (Shahriari et al., 2022). Molla & Cooper (2009) posit that Human factors are central to the realization of successes in GC implementation and play a vital role in driving competitiveness. Norton et al. (2015) shared a similar view and stated that the environmental sustainability agenda is highly dependent on employee behavior.

Likewise, Kim et al. (2019) found that green behavior among hotel employees increased environmental performance. It has been established in literature that organisational green culture leads to the effective implementation of green practices and behavior (Galpin et al., 2015), which enables firms to gain competitive advantage. The reason cited by Yeşiltaş et al. (2022) is culture puts pressure on individuals, forcing them to act in line of cultural values. Nanath and Pillai (2014) opined that green organisational culture plays a vital role in the effectiveness of Green IT implementation. Organisations that can imbibe green initiatives in the values, beliefs, and behaviors of the organisation are successful in incorporating sustainability measures (Nanath & Pillai, 2014). Abbas and Khan (2023) found that green culture strengthens the relationship between green knowledge management and organisational green innovation. Based on the above, it can be hypothesized that:

H8a: HEIs OGC positively moderates the relationship between effective GC implementation and Universities sustained competitive advantage

3.5.3.2 Leadership style (LS)

Leadership style refers to the relatively stable pattern of behavior that defines and differentiates a particular leader (DuBrin, 2022). Banini et al. (2021) identified various leadership styles including; autocratic, bureaucratic, charismatic, democratic, laissez-faire, people/relations-oriented, servant, task-oriented, transactional, and transformational leadership. Among the numerous types of leadership styles, transactional and transformation leadership are the most obvious in literature (Banini et al., 2021; Mahdinezhad & Suandi, 2013). Visser and Courtice (2011, p 6-7) identified “inclusive”, “visionary”, “creative”, “altruisive”, and “radical” as typical styles, leaders should have to effectively implement sustainability. The key to competitive advantage is for firms to be able to sustain the advantages gained from superior resources (Akter et al., 2020; Ghisetti & Rennings, 2014).

Sustained competitive advantage comes from a firm's resources and capabilities and includes management skills, organisational processes and skills, information, and knowledge (Ferreira, Coelho & Moutinho, 2020; Khan, Yang & Waheed, 2019; Ying, Hassan & Ahmad; 2019; Barney, 1991; Hall, 1993). According to Sun (2002), leadership style has a significant positive relationship with organisation performance in schools and enterprises. AlNuaimi et al. (2021) proposed that both transformational and transactional leadership style positively affects green procurement.

In support of this assertion, Özgül and Zehir (2022) found that top management's green transformational leadership positively influences green organisational learning capability, which has a positive indirect effect on competitive advantage.

Based on the above discussions, the following hypothesis was inferred for this study:

H8b: HEIs LS positively moderates the relationship between effective GC implementation and Universities sustained competitive advantage

3.5.4 Dependent Variable (DV)

3.5.4.1 Universities Sustainable Competitive Advantage

The term competitive advantage is defined as the long-term benefits of implementing business strategies that put a firm in a superior position because of their unique products or service offerings (Mataruka, 2022; Sigalas, 2015; Herrera, 2015). According to Sihite et al. (2016), competitive advantage in the educational sector could be assessed from different indicators such as brand image, profitability, quality, and capability. Additionally, sustained competitive advantage comes from a firm's rare and non-imitable resources and capabilities and includes management skills, organisational processes, information, and knowledge (Chavez et al., 2017; Barney 2011; Barney, 1991).

Researchers have stressed that the key to competitive advantage is for firms to be able to sustain the advantages gained from superior resources (Akter et al., 2020; Ghisetti & Rennings, 2014). It is important to note that more recent studies have shown a significant effect of environmental initiatives on competitive advantage (Singjai et al., 2018; Fraj et al., 2015; Leonidou et al., 2013). In a study conducted by Chen (2008), he found that green intellectual capital positively affected enterprises' competitive advantage. Along these lines, Leonidou et al. (2013) proposed that green-marketing strategies enable firms to reduce long-term costs and offer products and services that are different from those of competitors.

Menguc et al. (2010) claimed that customers are likely to pay more for environmentally friendly products and services, consequently, such firms would gain a competitive advantage and grow more than they would have otherwise. Ghisetti and Rennings (2014) stressed that green innovation can help create an "isolation barrier", based on core resources and capabilities that are difficult to imitate, enabling the enterprise to create a long-term advantage over competitors. Other researchers have stressed the impact of green innovation on business competitiveness (Tu & Wu, 2021; Yin et al., 2020, Borsatto & Amui, 2019) from the perspective of RBV (Mataruka, 2022; Sellitto et al., 2020; Berrone et al., 2013) and Dynamic Capability (Mataruka, 2022). That said it is evident that adopting and implementing GC effectively using unique resources and capabilities available to an organisation enables the implementing organisation to gain a competitive advantage and sustain it over time.

3.6 Chapter Summary

The chapter looked at the theoretical underpinnings for the study and provided an overview of the chosen RBV and DC theories for the study. A conceptual framework was formed by combining the RBV and DC theories. In addition, the constructs of the theories were briefly described. In all, nine (9) hypotheses were developed based on literature that has used DC and RBV theories, which helped answer the second, third, and fourth research questions. The next chapter discussed the research methodology for the study.

CHAPTER FOUR

METHODOLOGY

4.1 Chapter Overview

This chapter presents a thorough discussion of the methodology for the study including the research philosophical paradigm, research design, research method, sampling methods, data collection instruments, and data analysis.

4.2 Research Paradigm

Paradigm, also known as philosophical assumption is important for almost all well-grounded research giving it the basis for which the study is designed and conducted (Shannon-Baker, 2016). Paradigms are beliefs and philosophical orientations about the world held by a researcher, which inform the basis for the study and what the researcher brings to the study (Creswell, 2017) indicating that the beliefs held by a researcher will likely lead to choosing either qualitative, quantitative or mixed method approach (Boateng, 2020; Creswell, 2014). Creswell (2017) is of the view that research credibility and generalizability is improved with the adoption of a research paradigm.

Albeit with some variations, three (3) main paradigms are established in information systems research, that is positivist, interpretive, and critical realism (Myers & Avison, 2002). The positivist paradigm emphasizes the collection and analysis of empirical data through objective observation and measurement (Boateng, 2020). Positivist researchers aim to uncover causal relationships between variables and rely on quantitative data to test their hypotheses (Boateng, 2020). Interpretive paradigm, on the other hand, assumes that social reality is complex and multi-layered and that it cannot be fully understood through a single route or a particular method or knowledge (Boateng, 2020). Interpretive researchers aim to understand the meanings and interpretations that individuals attach to their experiences (Creswell, 2014) and

rely on qualitative data-gathering instruments such as interviews, observations, and documents. Critical realism paradigm seeks to "understand the underlying structures and mechanisms that produce observable phenomena" as it emphasizes the importance of explaining context, history, and power dynamics in shaping social phenomena (Elster, 1998, p. 45). Additionally, it combines the rudiments of positivism and interpretivism and acknowledges the existence of objective reality while recognizing that our "knowledge of this reality" is mediated by our "subjective experiences and social structures" (Creswell, 2014, p. 20).

According to Creswell (2014), each paradigm has its own ontological, epistemological, and methodological perspective that guides the research design. Ontological assumptions denote how researchers view the nature of reality and determine what constitutes legitimate research questions (Creswell, 2014). Epistemological assumptions refer to how knowledge is understood and the nature of knowledge (Park, 2019). Moon and Blackman (2014) explained that epistemology is concerned with the validity, scope, and methods of acquiring knowledge and that genuine knowledge is objective and quantifiable, and the goal of science is to test and expand theory. Methodological assumptions refer to the plan of action, process, or design behind the choice and use of particular research methods, techniques, or strategies (Creswell, 2014). Lincoln et al. (2011) stated that quantitative, qualitative, and mixed methods are among the methodological dimensions (Ahmed, 2008). Table 4.1 summarizes the different philosophical stances appropriate for use in social sciences research

Table 4.1: Comparison of Research Philosophies

Concept	Positivism	Interpretivism	Critical Realism
Ontology	External, objective and independent of social actors.	Socially constructed, subjective, may change, multiple reality	It is objective, two world-transitive and intransitive. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)
Epistemology	Only observable phenomena can provide credible data, and facts. Focus on causality and law-like generalization, reducing phenomena to simplest elements	Subjective meanings and social phenomena. Focus upon the details of a situation, a reality detail, and subjective meanings motivating actions.	Observable phenomena provide credible data and facts. Alternatively, phenomena create sensations, which are open to misinterpretations. Focus on explaining within a context.

Methodology	Highly structured, large samples, measurement, quantitative, but can use qualitative.	Small samples, in-depth investigations, qualitative.	Mixed or multiple method designs, quantitative and qualitative

Source: Author's construction

4.2.1 Choice of Positivist Paradigm

With the above discussions, the positivist paradigm is adopted for this study. The choice of the positivist paradigm was ideal for this study based on the study's purpose, problem statement, and sample size. According to Parker (2019), the positivist paradigm is suited for studies that uncover causal relationships between variables and arguably rely on quantitative data to test their hypotheses where findings derived from empirical evidence and large sample sizes are preferred. This study sought to establish the causal relationship between unique resources and capabilities of universities (independent variables) and effective GC implementations and sustained competitive advantage (dependent variables) and test hypotheses based on a conceptual framework using a stratified sample of 200 respondents. Creswell (2017) maintains that positivists usually collect large data for statistical analysis to validate and generalize research. Again, this study employed the use of online questionnaires as a data collection instrument, which allowed the researcher to eliminate bias by not interacting with the study's respondents. This relates to Parker (2019) when he concluded that positivist research functions in a dualistic and objective framework, where the researcher remains distinct from the study participants during design and data collection to reduce bias.

4.3 Research Design and Method

As explained by Al-Ababneh (2020), research design is the framework adopted by researchers to determine the methods and techniques chosen to carry out the research procedure. According to Creswell (2009), research design is the overall strategy and plan that a researcher uses to answer the research questions by collecting and analyzing empirical data. Thakur (2021, p. 175) states that a good research design should be coherent, logical, and effectively address the research objectives and questions, ensuring that the data collected answers the research questions satisfactorily.

Creswell (2009) posits that quantitative, qualitative, and mixed approaches are the three methods of research design. Creswell and Clark (2010) emphasized that the success and reliability of a research depend on the research methodology adopted.

4.3.1 Qualitative Method

Qualitative research aims to explore the beliefs, values, opinions, and attitudes underlying people's behavior concerning a particular phenomenon or concept. As reported by Boateng (2017b), the focus of qualitative research is to get a deeper understanding of a phenomenon rather than testing relationships to agree or disagree with a theory. According to Mingers (2004), qualitative methods are associated with the interpretive paradigm.

4.3.2 Quantitative Method

This method focuses on collecting and analyzing numerical data to quantify a study (Bryman, 2012) to measure differences among variables and the significance of those differences. According to Glitz (1997), numerical differences can be compared using statistical methods to confirm or test a theory or hypothesis. According to Mingers (2004), the positivist paradigm is associated with the quantitative method.

4.3.3 Mixed Method

The mixed method involves combining both quantitative and qualitative methods to provide a more holistic view of a concept or phenomenon, which cannot be fully understood using only quantitative or a qualitative method (Creswell, 2017). Morgan (2007) also believed that both qualitative and quantitative approaches could be combined to build on their strengths and weaknesses. Mingers (2004) associates the mixed methods approach with the critical realism paradigm, while Creswell (2009) and Morgan (2007) argue that it aligns with pragmatic researchers, who are not committed to any single philosophical system or view of reality.

4.3.4 Choice of Quantitative Method

The research problem sought to assess the inherent resources and capabilities of HEIs that contribute to effective GC implementation in Ghanaian Universities leading to sustained competitive advantage. Creswell (2017) indicated that the quantitative method is ideal for research focused on identifying the factors that affect an outcome. Additionally, the focus of this study is driven by the quantitative method as it seeks to test formulated hypotheses based on the constructs in the RBT and DC theory. The quantitative method aligns with the positivist paradigm for developing knowledge (Creswell, 2017) through strategies such as experiments and surveys. According to Yin (2003), quantitative research answers "what" or "how many" research questions and is recommended for use in studies to assess a problem or phenomenon. Again, Yin (2003) posits that "three conditions: the type of research question posed, the extent of control the researcher has over actual behavioral events, and the focus on contemporary as opposed to historical events" influence the choice of a research design or strategy.

Quantitative research helps understand the relationship between independent variables and one or more dependent variables. Hence, the choice of quantitative approach for this study helps to understand the relationship between the resources and capabilities of HEIs and effective GC implementation and universities' sustained competitive advantage. Yin (1994) advocates the use of the quantitative method for a sample representing a large population, usually more than 50, and applying formalized statistical analysis tools to analyze the data collected. Quantitative method authenticates the objectivity of the study by eliminating personal bias as the researcher keeps a distance from the participating subjects ensuring optimal accuracy of the study results and generalizability (Saunders, Lewis, and Thornhill, 2019; Kankam, 2019). Table 4.2 provides a summary of the choices of research designs or strategies along with the relevant questions.

Table 4.2: Situations for different research strategies

Strategy	Research Questions Posed	Requires control of behavioral events	Focuses on contemporary events
Survey	Who, What, Where, How much/many	No	Yes
Experiment	How, Why	Yes	Yes
Case Study	How, Why	No	Yes
History	How, Why	No	No

Source: Yin (2003)

4.4 Research Strategy and Purpose

According to Saunders et al. (2019), quantitative research takes different purposes, including exploratory, descriptive, and explanatory. Often, exploratory is used when little is known about a topic or concept and aims to identify new ideas or insights (Saunders et al., 2019). Descriptive on the other hand, seeks to describe a phenomenon or population to provide a snapshot of the current state of the phenomenon or population (Creswell, 2017). While explanatory research aims to establish causal relationships between variables (Saunders et al., 2019).

The study therefore takes the descriptive as well as explanatory approach. The above explanations affirm the reason for the selected research purposes and conform to the positivist stance of this research. The descriptive research helps achieve the first objective of the study, which is to assess the current state of GC implementation in Ghanaian Universities. Lastly, the explanatory research helped establish the association between the resources of universities and effective GC implementations leading to sustained competitive advantage.

Descriptive research involves collecting data through methods such as surveys, questionnaires, and observation while explanatory research involves testing hypotheses and theories through experiments, surveys, and statistical analysis (Creswell, 2017). The survey method is used to collect data for this study, which also aligns with the positivist paradigm (Creswell, 2017). Survey methods are suitable for studying different variables at an instance other than what field experiments can achieve (Reference). Survey research, as defined by Nesbary (1999, p.10) is "the process of collecting a representative sample from a larger population and using the sample to infer attributes of the population". Lastly, Hair, Black, and Anderson (2010), recommend the use of a survey in studying the cause of a phenomenon with empirical evidence to attitudes and behaviours of institutions.

4.5 Target Population

Bhardwaj (2019) suggests that the target population forms the assortment of the public from which the researcher needs to gather data. According to GTEC (2022), there are ten (10) public and over fifty(50) private universities spread across the sixteen (16) regions of Ghana. The study targeted all these universities in Ghana. The subjects of the study were specifically ICT directors/heads, Data centre managers, network administrators, IS/IT Faculty members, IT support staff, system administrators, system analysts, IT procurement officers, and other administrative heads who are the decision-makers in terms of technology adoption and implementation.

It was important to involve these respondents from the HEIs being studied as involving them can help ensure that the study is relevant and practical and that the findings are actionable for the institutions being studied. Additionally, involving stakeholders in the research process can help build support for the study and increase the likelihood that the findings will be used to inform policy and practice.

4.6 Sampling Size and Frame

The study sought to question 200 target respondents from universities in Ghana by distributing online and self-administered questionnaires. According to the tenets of Partial Least Squares - Structural Equation Modelling (PLS-SEM), which was used to analyze data for this study, the '10-times rule", the most widely used minimum sample size estimation for an unknown research study population is used to achieve sample adequacy (Hair et al., 2014, p. 20-21). The 10-times rule indicates that the minimum sample size for research should be more than 10-times the construct or variable with the maximum number of indicators in the research framework (Hair et al., 2021, p.16; Hair et al., 2014, p.20). With the research conceptual framework in Chapter Three and the sample questionnaire in Appendix B, the constructs with the maximum number of indicators or measurement items are Capabilities and Universities Sustained Competitive Advantage (7 indicators). This meant a minimum sample size of 70 was ideal for this study. However, the study considered 200 respondents, though more than the minimum required, it is still statistically representative of the study's target population. Online questionnaires were distributed through respondents' institutional email addresses, which were acquired from the various institutions' staff directory portals. For the sampling frame, the study divided Universities in Ghana into 2 strata, private and public universities, registered and in good standing with GTEC.

4.7 Sampling Technique

Two main sampling techniques are popular in social science research, namely, Probability and Non-probability sampling (Khan, 2020; Bhardwaj, 2019). In probability sampling, every individual in the population has an equal chance of being selected (Bhardwaj, 2019). Khan (2020) identifies simple random, stratified random, cluster, and systematic sampling as the methods of probability sampling. On the other hand, non-probability sampling relies on

researchers own verdict to select elements or individuals for the study and not on chances (Malhotra & Birks, 2007) as evident in probability sampling. Bhardwaj (2019) identifies the types of non-probability sampling as purposive, quota, snowball, and convenience sampling.

The study used a probability-based stratified sampling technique by dividing universities in Ghana into two strata, Public universities and Private universities. Stratified sampling allows for the sub-categorization of a larger population (Bhardwaj, 2019) to ensure specific subgroups are present in the research sample (Parsons, 2014). This maximizes the statistical efficiency of the sample and offers enough data to study the different subgroups of the population (Lakens, 2022). Thereafter, due to the technicality of the GC concept, purposive sampling was used in the distribution of questionnaires to only the specific respondents in the various universities. The purposive sampling method allows the researcher to make a deliberate choice of participants who have knowledge or experience of the issues being addressed (Hair et al., 2019) and can provide relevant information for the research purpose.

4.8 Data Collection Method and Instrument Development

The descriptive and explanatory nature of the study allows primary data to be collected through surveys, experiments, and direct observation (Pandey & Pandey, 2021). To this end, the study used the survey method to collect cross-sectional data from the study's respondents using a standardised set of questions in other to establish a cause-and-effect relationship between variables (Creswell & Hirose, 2019). Experiment was not appropriate due to the limited timeframe of the study. Furthermore, it was impossible for direct observation due to the dispersed geographical locations of the respondents and the cost involved if this method was chosen (Pandey & Pandey, 2021).

4.8.1 Data Collection Instrument: Questionnaires

Malhotra and Birks (2007) explain that four key instruments, namely: member opinion, individual meetings, phone meetings, and self-administered questionnaires can be used to collect primary data. Since this study adopts the positivist stance and the quantitative approach, the use of questionnaires for this survey research is considered fit as a data collection instrument. According to Sekaran and Bougie (2016), questionnaires as a data collection instrument ensure standardization, impartiality, and consistency, in addition to ensuring a degree of anonymity since questionnaires are answered in the comfort and privacy of the respondents. With questionnaires, standardized closed-ended questions can be administered to a large sample easily and inexpensively (Ali, 2022). This section led to the design of the questionnaires.

4.8.1.1 Questionnaire Design

Questionnaires were adapted from Mithas et al. (2010), Mataruba (2022), Chen et al. (2008), Boateng et al. (2021), Abbas and Khan (2023), Wang el al., (2022) and Kor and Mesko (2013). The constructs in the study's conceptual framework were measured using a 5-point Likert scale of 1 to 5, where 1= Strongly Disagree (SD), 2= Disagree (D), 3= Neutral (N), 4= Agree (A), 5= Strongly Agree (SA). The 5-point Likert scale is known to provide outcomes that are accurate and consistent for multivariate data analysis (Hair, Black, Babin, & Anderson, 2010). Likewise, with the 5-point Likert scale, respondents' views can be easily quantified using a combination of scores of responses on different items into a single index (Likert, 1932). The questionnaire comprised six sections. Section A aimed to collect demographic data of respondents. Section B captured data on the GC concept under study, which helped to answer the study's research question 1. Section C of the questionnaire focused on the unique resources and capabilities that account for effective GC implementations in HEIs; therefore, it answered

research 2. Furthermore, Section D measured the effectiveness of GC implementations in HEIs, whereas Section E focused on the green culture and leadership style, which moderate the relationship between effective GC implementation, and Universities' sustained competitive advantage. Lastly, Section F of the questionnaire gathered data for the study's main dependent constructs, Universities Sustained Competitive advantage. Table 4.3 provides a summary of the constructs and the sources from where the survey questions were adapted. A sample of the questionnaire has been shown in Appendix B.

Table 4.3: Constructs, number of measurement items and their sources

Construct	**Number of Items**	**Source**
Resources	5	Mataruba (2022)
Assets	5	Mataruba (2022)
Capabilities	7	Chen et al. (2008); Kor and Mesko (2013); Mataruba (2022)
Absorptive capacity	6	Mataruba (2022); Boateng et al. (2021); Chen et al. (2009)
Agility	6	Mataruba (2022)
Environmental turbulence	5	Odoom (2015)
Effective GC implementations	5	Mithas et al.(2010); Gholami et al. (2017)
Green organisational culture	6	Abbas & Khan (2023); Wang el al. (2022)

Leadership style	6	Yeşiltaş et al. (2022); Nanath & Pillai (2014).
Universities sustained competitive advantage	7	Mataruba (2022); Chen et al. (2009)

Source: Author's construction

4.9 Data Analysis Method

According to Hair et al. (2014), data analysis for a quantitative study is done with statistical methods, using statistical tools. Tracy (2019) supports this assertion, explaining that data analysis involves multiple facets and includes methods that help describe facts, identify patterns, develop explanations, and test hypotheses. For this reason, after the data was collected through open-ended questionnaires, they were analyzed using descriptive statistics and multivariate statistical analysis tools, specifically, Statistical Package for Social Sciences (SPSS) version 25 and Partial Least Squares Structural Equation Modelling (PLS-SEM) SmartPLS version 4 respectively.

4.9.1 Descriptive Data Analysis

First, to answer the study's research question one, the demographics of respondents and SPSS were used to analyze the data for description. Descriptive analysis helps to establish central tendencies such as mean, median, or mode and dispersion such as range, variation, and the coefficient of variation (Hair et al, 2021). According to Wang (2021) for most studies, conducting descriptive analysis is key before conducting most of the additional validation and statistical analyses.

4.9.2 Data Analysis using Partial Least Square in Structural Equation Modelling

In recent years, IS researchers have extensively embraced Structural Equation Modeling (SEM), a multivariate data analysis method, purposely for validating constructs and examining the associations between them (Hair et al., 2019). Two main approaches are mostly applied in SEM, a Compound or Variance-Based approach (PLS-SEM) and Co-variance Based approach (CB-SEM) (Rigdon et al., 2017). These approaches vary in terms of their fundamental statistical assumptions (Reference). PLS-SEM uses software tools such as SmartPLS and ADANCO (Wang, 2021; Sarstedt et al., 2020, Afthanorhan et al., 2020) whiles CB-SEM uses software packages such as Mplus, AMOS, LISREL, etc. (Hair et al., 2019; Sarstedt et al., 2021).

PLS-SEM was used for this study because this technique can estimate more complex models with many constructs using a smaller sample size (Hair et al., 2019; Ringle et al., 2012) and it does not require the dataset to be normally distributed (Sarstedt et al., 2021; Hair et al., 2019). Furthermore, PLS-SEM was useful in estimating the relationships between the latent and observed variables in the conceptual framework in Chapter 3. This way, regression and correlation analyses were done to help understand how the dependent variables (Effective GC implementation and Universities sustained competitive advantage) are better predicted by the independent variables (Resources, Assets, Capabilities, Agility, AC, and EC). This form of statistical analysis helped answer the study's research questions two, three, and four.

4.9.2.1 Steps in PLS-SEM Data Analysis

In SEM, it is noteworthy that two elements are used in assessing the quality of the data which consists of assessing the measurement model and structural model (Hair et al., 2021). The first element, which is the assessment of the measurement models, also referred to as the outer model, helps to assess two criteria the reliability and validity of the study's constructs (Sarstedt

et al., 2021). It includes checking the model for internal consistency, indicator reliability, convergent validity, and discriminant validity.

PLS-SEM, like the majority of statistical techniques, involves rules that can be used as a guide when assessing model outcomes (Hair et al., 2019; Hair et al., 2017a) depending on whether the constructs are reflective or formative (Hair & Alamer, 2022). A change in Reflective constructs causes similar changes in their indicators whereas, for formative constructs, changes in the indicators cause equal changes in their associated constructs (Hair et al., 2021)

The first rule is that, for reflective constructs, which is the case for this study, PLS-SEM requires the researcher to examine the measurement models before assessing the structural model (Hair et al., 2021). Measurement model assessment includes checking the model for internal consistency, indicator reliability, convergent validity, and discriminant validity.

The second rule is to assess the structural models also known as inner models after meeting the criteria in the measurement model (Hair et al., 2021; Hair et al., 2019). Assessment of the structural model involved checking the relationship between the independent variables and the dependent variables of the study. Hair et al (2019) and (Sarstedt et al., 2021) suggested five critical steps are necessary to assess the structural model. These include assessing the structural model for collinearity, significance, and relevance of relationships, Goodness of Fit (GoF), effective size (f-square), and finally, predictive relevance (q-square).

4.9.2.2 Ethical Considerations

Malhotra and Birks (2007) claimed there is a positive relationship between ethics and the quality of research, ultimately assuming that research of low quality tends towards being ethically unacceptable. Furtherance to this, Malhotra and Birks (2007) highlighted the following ethical considerations for scientific research, namely anonymity and confidentiality, permission and the right to informed consent.

Owing to these reasons, the respondents of the survey questionnaire were given the chance to consent to participating in the study without being coerced. In addition, under no circumstances were respondents required to provide personal information like name, date of birth, etc. This was all geared towards ensuring the anonymity and confidentiality of respondents. For a thorough understanding of the study, the purpose of the study was clearly explained before the participant attempted to answer the questionnaire. Furthermore, the University of Ghana's code of conduct concerning research work was strictly adhered to by the researcher.

For this reason, it was required to obtain an introductory letter from the department of Operations and Management Information Systems (OMIS) as a form of permission to be able to collect data from the study's respondents. A copy of the introductory letter has been shown in Appendix A. Additionally, the study duly acknowledged and included in the reference lists all cited academic works.

4.10 Chapter Summary

This chapter discussed in detailed the methodology used for the study, with a focus on the research paradigm, research design, data collection method, and techniques. The chapter also included a discussion on the sample size, target populace, and data analysis methods. The positivist paradigm formed the basis of this descriptive and explanatory quantitative cross-sectional study. Finally, there was a discussion on the choice of questionnaires as the data-gathering instrument and the ethical considerations for the study.

CHAPTER FIVE

FINDINGS AND ANALYSIS

5.1 Chapter Overview

This chapter presents the results and discusses the study serving as a foundation for the analysis of the data collected on GC initiatives implemented in Universities in Ghana and their effectiveness thereof. This chapter also presents how the proposed conceptual framework is assessed and confirmed using Partial Least Squares-Structural Equation Modelling (PLS-SEM). In addition, the study also sought to assess the extent to which leadership style and organisational green cultures influence the relationship between effective GC and Universities' sustained competitive advantage. As such, this chapter is in three parts. Firstly, the results on the demographic characteristics of the respondents are presented to help assess the nature of those who responded to the research questionnaire, including their gender, age, educational background, years of experience, and familiarity with GC. Secondly, the conceptual framework proposed in Chapter 3 is assessed using PLS-SEM to test the fit and validity of the model. Precisely, an assessment of the measurement and structural models is discussed in detail in Chapter 4. Finally, a presentation and discussion of the extent to which the effectiveness of GC implementation has sustained Universities' competitive advantage is done. In addition, the results on the extent to which organisational culture and leadership style moderate Universities' Sustainable Competitive Advantage are presented and discussed.

The results from the validation of the conceptual framework and the tested hypothesis led to the assessment of the influence of *resources, assets, capability, adaptive capacity, agility, and environmental turbulence on the effectiveness of GC Implementation and the moderating effects of leadership style and organisational green culture on the sustainability of competitive*

advantage in universities in Ghana. Importantly, these enabled research questions two (2), three (3), and four (4) to be answered easily.

5.2 Demographic Characteristics of Respondents

This section looked in detail at the demographic profile of the respondents sampled in the study. Demographic characteristics considered in this study included gender, age, level of education, category of university, name of university, job title, and years of experience. A total number of 134 samples were received, however, only 133 of the responses were valid. The respondents of the study were conveniently sampled from the 16 public and over 50 private HEIs in Ghana (GTEC, 2022). The data on the demographic characteristics of respondents is summarized in Table 5.1 below.

Table 5.1: Demographic Characteristics of Respondents

Demographic	**Characteristics**	**Frequency**	**Percentage**
Gender	Male	105	78.9
	Female	28	21.1
	Total	**133**	**100**
Age	21-30	24	18.0
	31-40	62	51.1
	41-50	33	24.8
	51-60	6	4.5
	Above 60	2	1.5
	Total	**133**	**100**

Level of Education	Diploma	9	6.8
	First Degree	48	36.1
	Masters	65	48.9
	PhD	3	8.3
	Total	**133**	**100**
University Category	Private	11	8.3
	Public	124	91.7
	Total	**133**	**100**
Name of University	UCC	43	32.3
	KNUST	18	13.5
	CSUC	3	2.3
	Akenten Appiah Menka	10	7.5
	UG	10	7.5
	UniMAC	2	1.5
	C. K. Tedam University	1	0.8
	HO Technical University	2	1.5
	UPSA	4	3.0
	UEW	11	8.3
	Garden City University College	5	3.8

	Kumasi Technical University	8	6.0
	GIMPA	2	1.5
	UMaT	5	3.8
	Academic City	1	0.8
	Cape Coast Technical	4	3.0
	All Nations University	1	0.8
	UENR	1	0.8
	Others	2	1.5
	Total	**133**	**100**
Job Title	IT Staff	66	49.6
	IT Procurement officer	3	2.3
	ICT Manager	15	11.3
	Other Senior Manager	2	1.5
	ICT Director	5	3.8
	Other Director	1	0.8
	IT/IS Faculty Member	34	25.6
	Other Faculty Member	2	1.5
	Network Administrator	1	0.8
	System Analyst	3	2.3

	Attachment student	1	0.8
	Total	**133**	**100**
Years of Experience	2years and below	12	9.0
	2 – 5 years	49	36.8
	6 – 10 years	34	25.6
	11 – 15 years	24	18.0
	15years and above	14	10.5
	Total	**133**	**100**
Familiarity with GC	Yes	115	86.5
	No	18	13.5
	Total	**133**	**100**
GC Importance	Yes	96	83.5
	No	19	16.5
	Total	**115**	**100**
GC Initiatives Implemented in Universities	Energy-efficient Appliances	72	
	Thin Client Computers	43	
	Energy-efficient Data centers	36	
	E-learning portals	100	
	Online Applications/ Admissions	42	

	Green Policy	2	
	Green Strategy	1	
	Telecommuting	10	
	Sustainability Champions or Administrators	7	
	Efficient E-waste Disposal	4	
	E-waste Recycling	1	
	Cloud Computing	42	
	Server Virtualization	18	
	Centralized Power Management	8	
	Online Assessments/ Examinations	35	
	Green Procurement	1	
	Green Awareness and Training	0	
	Electronic Pay-slips	54	
	Institutional Email Use	56	

Is there an explicit and vigorous commitment to GC Implementation in Universities?	Yes	35	30.4
	No	41	35.7
	Not sure	39	33.9
	Total	**115**	**100**

Source: Author's field survey, 2024

Table 5.1 presents a tabular distribution of the characteristics of the sampled respondents. The table statistically depicts the frequencies and percentages of demographic responses on gender, age, educational qualifications, affiliated university name, and its category, respondents' job title, and the number of years worked.

A total number of 134 people responded to the questionnaire, 124 from public universities and 11 from private universities. However, one of the responses was rejected for incompleteness; as such, 133 responses were used for the data analysis. Of the total number of respondents, 105**,** indicating 78.9 percent were males, and 28**,** indicating 21.1 percent were females. This finding implies that there are more males in IT professions and the general workforce in universities than females, which supports the findings made by Fry, Kennedy, and Funk (2021) and Abraham, Ohemeng, and Ohemeng (2017). This finding also confirms recent annual reports by The World Bank and Ghana Statistical Service, which indicated that there are more employed males than females in almost all sectors of the Ghanaian economy (The World Bank, 2022; Ghana Statistical Service, 2015).

In terms of age distribution, the age range of 60 and above had the lowest representation, with 1.5 percent. This was expected as it is assumed that such age group would have reached their end of service years and that if any are still active in service, they will be few on post-retirement

contracts. The age range 51 to 60 followed as the second lower representation of six (6), with 4.5 percent. Next was the Age range 21 to 30 with 24, representing 18 percent. The age range 41 to 50 had a representation of 33, which indicates 24.8 percent. Lastly, Age range 31 to 40 has the highest representation of 68 with 51.1 percent. It can be said that sustainability agenda through emerging trends, in this case, GC initiatives have gained popularity and interest among many millennials (persons born between the 1980 and the late 1990's) (Shamsi, Narula & Sharma, 2022; Squires, 2019)

Concerning respondents' level of education, the results indicate that most of the respondents, 65 had completed a Master's degree (48.9 percent), followed by a first degree, 48 (36.1 percent), and a PhD degree, 11 (8.3 percent). However, there was a lower number of respondents with diploma degrees, 9 (6.8 percent).

In totality, 91.7 percent of the respondents were from public universities, whereas 8.3 were from private universities. This indicates that there are more public universities than private universities in Ghana.

Regarding the number of respondents from each university, the University of Cape Coast had the highest number of representation, with 43 respondents (32.3 percent). KNUST followed immediately with 18 respondents (13.5 percent). UEW, UG, AAMUSTED, KsTU, and GUC have a representation of 11, 10, 10, 8, and 5 respectively.

In terms of the job positions of the respondents, IT staff had the highest number of representation, with 66 respondents (49.6 percent). IT/IS Faculty members followed immediately with 34 respondents (25.6 percent). ICT Managers, ICT Directors, IT Procurement officers, and System analysts had a representation of 15 (11.3 percent), 5 (3.8 percent), 3 (2.3 percent), and 3 (2.3 percent) respectively.

In their respective universities, 49 respondents have worked for 2 to 5 years with a representation of 36.8 percent. However, respondents with below 2 years of experience had the least representation (9.0 percent).

Additionally, 115 respondents (86.5 percent) were well aware and familiar with the term GC whereas 18 respondents (13.5 percent) indicated that they were not familiar with the concept. It is worth noting that, the 18 respondents who were not familiar with the concept under study were not allowed to proceed with answering further questions.

Regarding the importance of GC, 96 respondents (83.5 percent) out of the 115 respondents who were familiar with GC acknowledged the importance of GC to their respective universities. However, 19 respondents (16.5 percent) thought that GC is of little to no importance to their respective universities.

Regarding the type of GC initiatives adopted and implemented in HEIs in Ghana, E-learning portals (100) were determined as a predominant GC initiative implemented in their respective university, followed by the use of energy-efficient appliances. The least among the GC initiatives were Green Training and Awareness, Green Policy, Green strategy, Green Procurement, and E-waste recycling.

Lastly, 35 respondents (30.4 percent) acknowledged that though there are varied forms of GC initiatives implemented in their affiliated universities, there has not been a formalized explicit and vigorous commitment by the top management or leadership in terms of GC adoption and implementation. However, 41 respondents (35.7 percent) of the respondents disagreed with this claim while 39 respondents (33.9 percent) were not sure.

5.3 Descriptive Statistics

This section details the descriptive statistics of the measurement items of the study to determine the means and standard deviations. The means indicate the extent to which the study's respondents agreed or disagreed with the questionnaire's statements whereas standard deviations reveal the extent of variability in their responses. From Table 5.2, the lowest mean recorded among the independent constructs was 2.30, relating to Intangible Assets "Our institution has policies on GC implementations (Green use, green disposal)" and "Our institution has documented GC implementation strategies". These means indicate that respondents do not generally show strong agreement with the fact that their respective HEIs in Ghana have policies and strategies in place for GC implementations. In addition, the standard deviations of 1.08 and 1.00 respectively indicate significant variability in responses. The highest mean was 4.30, relating to Resources "Physical and Technological infrastructure (including datacentres, energy-efficient hardware, software, and systems) enable our institution to implement sustainable computing practices." The mean gives a strong affirmation that physical and technological resources are needed for effective GC implementation in HEIs in Ghana. The standard deviation of 0.87 indicates some variation in responses but generally consistent agreement.

On average, concerning effective GC implementations (EGC), EGC1's (GC Implementation has helped reduce our I.T. equipment energy consumption) mean of 4.10 indicates strong agreement, accompanied by a standard deviation of 0.89 reflecting moderate variability. In contrast, EGC4 (GC Implementation has helped reduce our carbon footprints), with the lowest mean of 3.32, suggests moderate agreement and has a standard deviation of 0.82, which indicates lower variability. Regarding universities' sustained competitive advantage (SCA), respondents expressed moderate agreement, as all means were below 4.0. Additionally, the standard deviations indicated variability in the responses.

Table 5.2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
RE1	115	1	5	4.15	0.840
RE2	115	1	5	4.30	0.870
RE3	115	1	5	2.99	1.158
RE4	115	1	5	3.14	1.139
RE5	115	1	5	3.42	0.858
ITA1	115	1	5	3.83	0.881
ITA2	115	1	5	2.30	1.076
ITA3	115	1	5	2.30	1.000
ITA4	115	1	5	3.57	1.052
ITA5	115	1	5	2.99	1.112
CAP1	115	1	5	3.93	0.953
CAP2	115	1	5	3.82	0.970
CAP3	115	1	5	2.79	1.210
CAP4	115	1	5	3.83	0.826
CAP5	115	1	5	2.92	1.229
CAP6	115	1	5	2.92	1.061
CAP7	115	1	5	3.55	0.976
AC1	115	1	5	2.94	1.070
AC2	115	1	5	3.03	1.088
AC3	115	1	5	3.11	1.007
AC4	115	1	5	3.71	0.944
AC5	115	1	5	3.70	0.929

AC6	115	1	5	2.90	1.059
AG1	115	1	5	3.65	0.899
AG2	115	1	5	3.12	1.069
AG3	115	1	5	3.20	1.086
AG4	115	1	5	3.03	1.092
AG5	115	1	5	3.50	1.079
AG6	115	1	5	3.34	1.091
ET1	115	1	5	4.03	0.888
ET2	115	1	5	2.68	1.253
ET3	115	1	5	3.82	0.833
ET4	115	1	5	3.85	0.891
ET5	115	1	5	3.69	1.029
EGC1	115	1	5	4.10	0.892
EGC2	115	1	5	4.09	0.833
EGC3	115	1	5	3.40	1.122
EGC4	115	1	5	3.32	0.822
EGC5	115	1	5	3.60	0.846
OGC1	115	1	5	3.93	0.758
OGC2	115	1	5	3.90	0.805
OGC3	115	1	5	2.59	0.990
OGC4	115	1	5	2.67	0.998
OGC5	115	1	5	2.67	1.066
OGC6	115	1	5	3.30	1.019
LS1	115	1	5	2.98	1.124

LS2	115	1	5	2.77	0.994
LS3	115	1	5	2.97	0.977
LS4	115	1	5	2.51	0.958
LS5	115	1	5	3.03	1.051
LS6	115	1	5	2.77	1.001
SCA1	115	1	5	3.70	0.993
SCA2	115	1	5	3.43	1.077
SCA3	115	1	5	3.76	0.914
SCA4	115	1	5	3.75	0.944
SCA5	115	1	5	2.49	1.217
SCA6	115	1	5	3.30	0.870
SCA7	115	1	5	3.20	0.948
Valid N (listwise)	115				

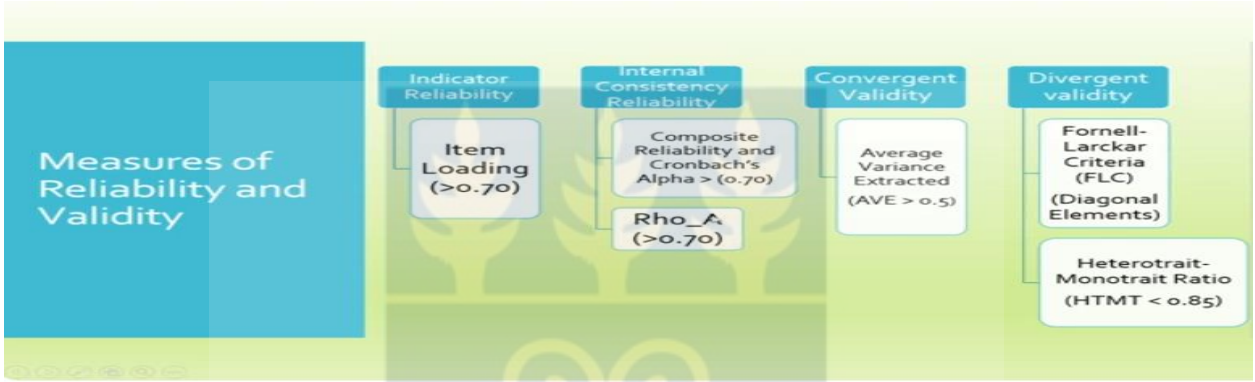
Source: Author's construction

5.4 Assessment of the Measurement Model

In SEM, the quality of the data needs to be satisfied in the measurement model before an assessment of the structural model can be done (Hair et al., 2021). The assessment of the measurement models, also referred to as the outer model, helps to assess two criteria, the reliability and validity of the study's constructs. Reliability measures the extent to which the research instrument is expected to give the same results if the measurement is repeated (Sürücü & Maslakci, 2020). On the other hand, validity is the extent to which an instrument, in this case, the questionnaire measures what it is supposed to measure, instead of another (Hair et al., 2021; Aithal & Aithal, 2020).

In this study and as indicated in Figure 5.1, the constructs' reliabilities were tested by checking the model for internal consistency and indicator reliability whereas validity was achieved by checking the convergent validity and discriminant validity of the model. Researchers have explained that these checks ensure that the normal decision rules are applied (Pesämaa, Zwikael, HairJr, & Huemann, 2021; Hair et al., 2019)

Figure 5.1: Measures of Reliability and Validity



Source: Adopted from Hair et al. (2019)

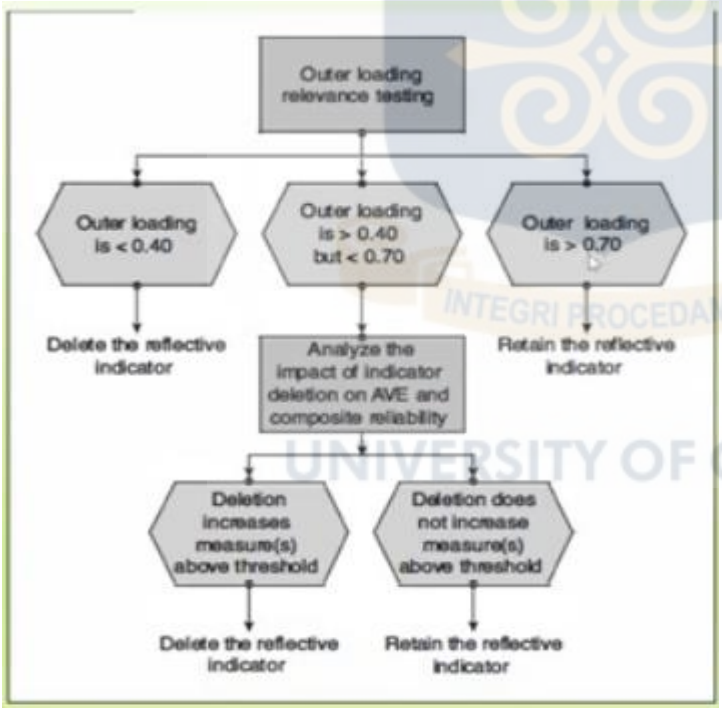
5.4.1 Indicator Reliability

Indicator reliability refers to the commonality of an indicator, evaluating how much of each indicator's difference is explained by its construct (Hair et al., 2021). It is the first step in the measurement model evaluation (Hair et al., 2021). Indicators with outer loadings greater than 0.708 are desirable as they suggest that the construct accounts for over half of the indicator's variance, hence offering satisfactory indicator reliability (Hair et al., 2019). The thresholds for reliability and validity measures considered in this study are depicted in Figure 5.2.

Additionally, the loadings for the measurement items have been depicted in Figure 5.3. From Figure 5.3, it is evident that some measurement items ((RE3, RE4, CAP 3, CAP5, CAP 6, CAP7, ITA 1, ITA 2, ITA3, AC6, AG1, ET2, EGC 3, OGC1, OGC2, SCA5, SCA6 and SCA 7) did not offer satisfactory indicator reliability, as such, they were deleted from the model. This resulted in significant improvements in other measured indicators. The results after the measurement item with fewer loadings were deleted have been indicated in Figure 5.4 and Table 5.3 respectively.

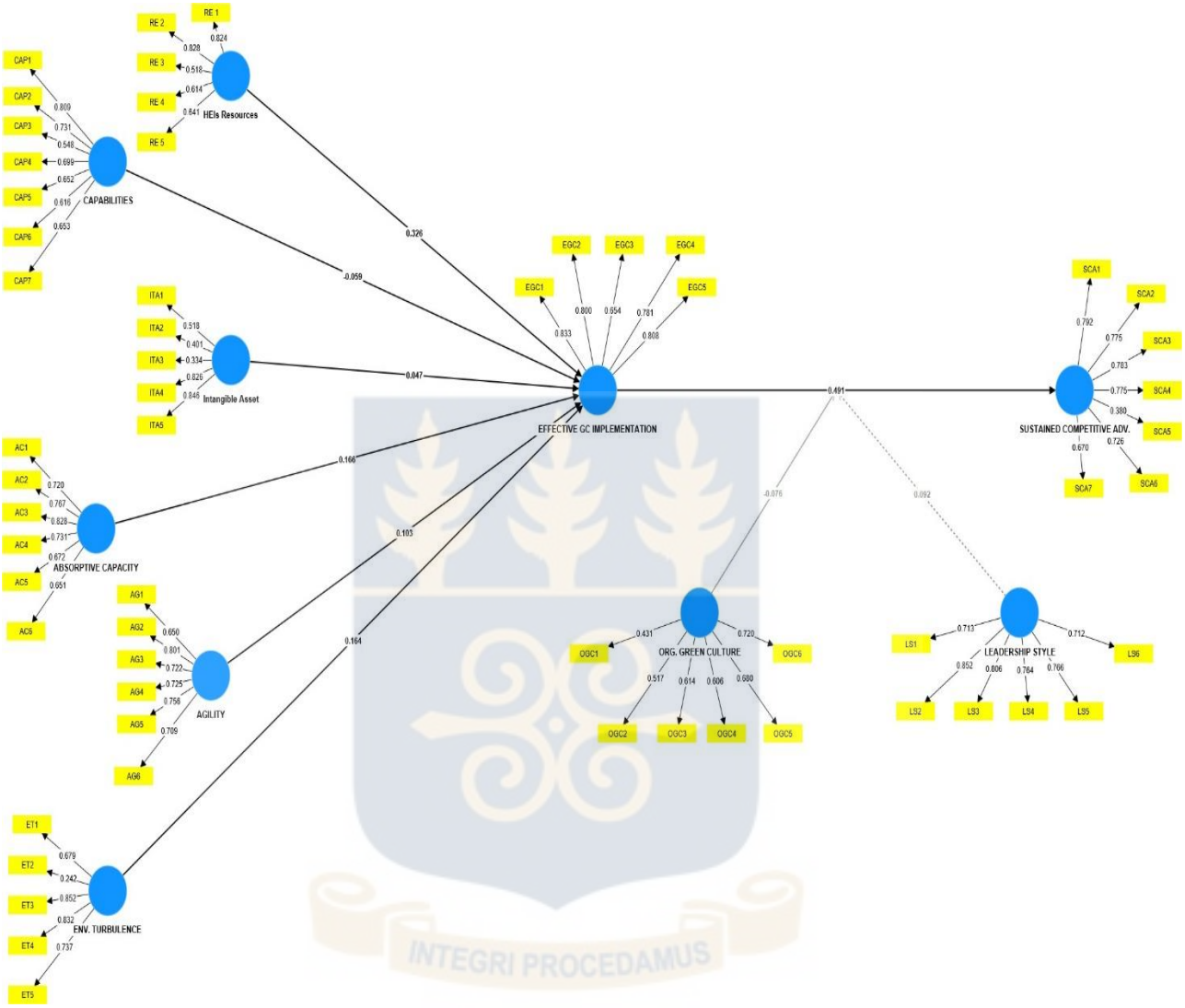
However, not all indicators with fewer loadings (RE5, AC1, AC5, LS6, OGC3, and OGC4) were deleted from the model since their removal did not have a significant effect on other reliability and validity measures (Hair et al., 2021, Hair et al., 2014).

Figure 5.2: Reliability and Validity Measures



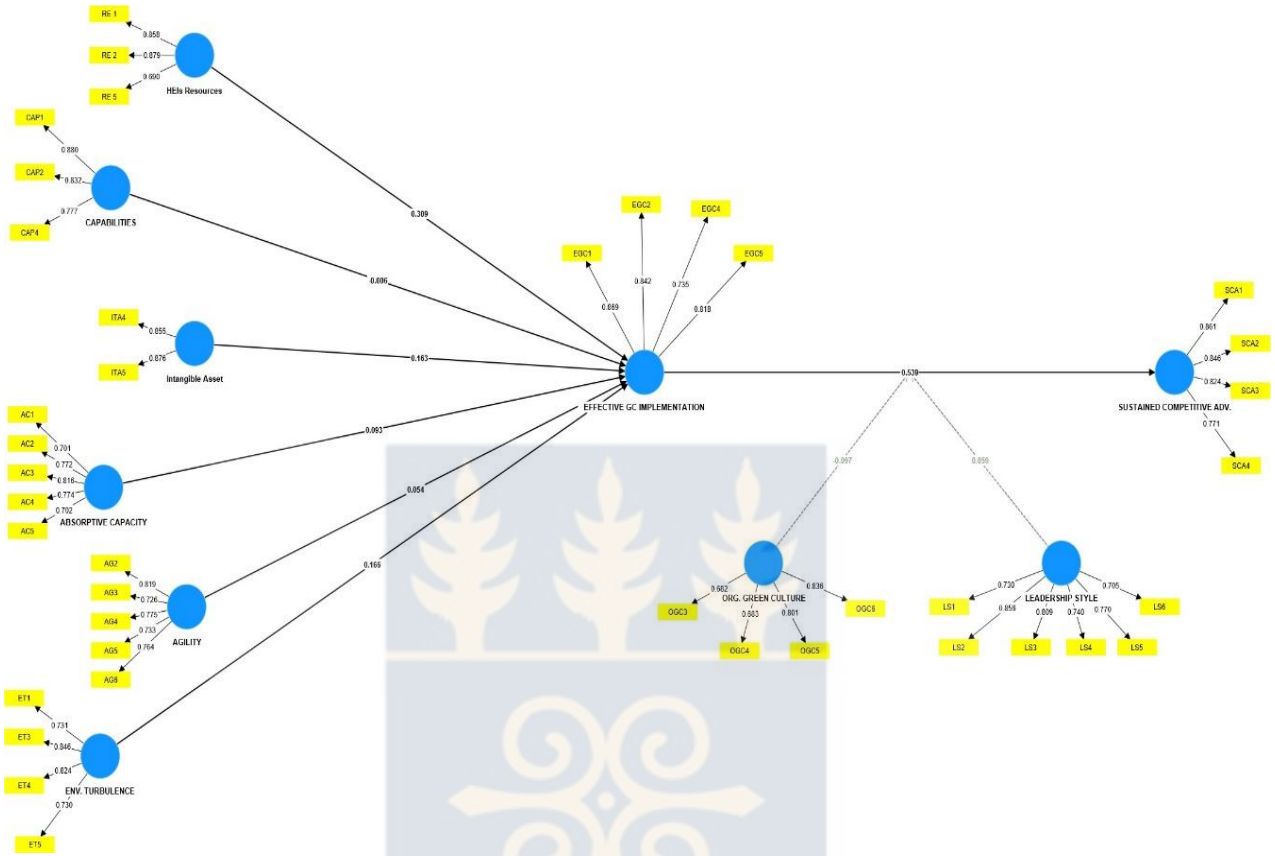
Source: Adopted from Hair et al. (2014)

Figure 5.3: Smart PLS Output (Initial Constructs Indicator Loadings)



Source: Smart PLS Output (2023)

Figure 5.4: Smart PLS Output (Constructs Indicator Loadings after deletion)



Source: Smart PLS output (2023)

5.4.2 Internal Consistency Reliability

This assessed whether the results across the measurement items within the same constructs are consistent (Hair et al., 2021). In other words, if the questionnaire items have similar scores or correlations (Aithal and Aithal, 2020). Internal consistency quality could be evaluated using either Cronbach's alpha, Jureskog's (1971) composite reliability (rho_c), or the consistent reliability coefficient (rho_a) (Hair et al., 2021, Hair et al., 2019; Dijkstra & Henseler, 2015; Dijkstra, 2014). Outputs from the analysis showing Cronbach's alpha, the consistent reliability coefficients (rho_a), composite reliability (rho_c), and the Average Variance extracted (AVE) between the constructs are summarized in Table 5.3.

A latent variable with a high Cronbach's alpha value suggests that all of its indicators have scores within the same range and meaning (Cronbach, 1951). According to Nunnally (1978), a minimum threshold of 0.70 Cronbach's alpha is ideal. From Figure 5.3, most of the constructs had alpha values greater than 0.70 indicating that the results across the measurement items within the same constructs are consistent. However, one construct (Intangible asset) had an Alpha value (0.66) which was less than the recommended Cronbach's alpha value of 0.70. Nonetheless, these indicator items were not deleted immediately since their removal did not have a significant effect on other fit and validity measures (Hair et al., 2021).

Researchers have proposed the use of Jureskog's (1971) composite reliability to measure the reliability of an indicator since Cronbach's alpha fails to consider the individual weights or loadings of each indicator item (Sarstedt et al., 2021; Dash & Paul, 2021 Hair et al., 2019). For exploratory study, Jureskog (1971) composite reliability values in the range of 0.6 to 0.7 are considered sufficient, while in advanced research, values in the range of 0.7 to 0.9 are acceptable (Dash & Paul, 2021). However, values above 0.90 are considered unsatisfactory, indicating that there may be problems with the indicator items, such as undesirable response patterns (Hair et al, 2021). From Table 5.3, the composite reliability values (rho_c) ranged from 0.839 to 0.897, which is within the permissible range of 0.6 to 0.9.

Subsequently, the consistent reliability coefficient (rho_a) has been proposed as the best measure of reliability between Cronbach's alpha and Jureskog's (1971) composite reliability (rho_c) (Dijkstra & Henseler, 2015; Dijkstra, 2014). A consistent reliability coefficient (rho_a) value of 0.70 and above is ideal (Hair et al., 2021). From Table 5.3, the consistent reliability coefficient (rho_a) values in this investigation ranged from 0.668 to 0.963, which was satisfactory. This implied that the results across the measurement items within the same constructs are consistent.

Table 5.3: Reliability of Constructs after Deletion

Constructs	Indicators	Loadings	Cronbach's alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Absorptive capacity	AC1 AC2 AC3 AC4 AC5	0.701 0.772 0.818 0.774 0.702	0.809	0.815	0.868	0.569
Agility	AG2 AG3 AG4 AG5 AG6	0.819 0.726 0.775 0.733 0.764	0.822	0.829	0.875	0.584
Capabilities	CAP1	0.880	0.776	0.783	0.869	0.690

	CAP2	0.832				
	CAP4	0.777				
	EGC1	0.899				
	EGC2	0.842				
Effective GC	EGC4	0.735				
implementation	EGC5	0.819	0.835	0.850	0.889	0.668
	ET1	0.731				
	ET3	0.846				
Environmental	ET4	0.824				
turbulence	ET5	0.730	0.793	0.795	0.865	0.616
	RE1	0.858				
	RE2	0.879				
HEIs resources	RE5	0.690	0.737	0.750	0.853	0.661
	ITA4	0.855				
Intangible assets	ITA5	0.876	0.666	0.668	0.857	0.749
Leadership style	LS1	0.730	0.862	0.872	0.897	0.593

	LS2	0.856				
	LS3	0.809				
	LS4	0.740				
	LS5	0.770				
	LS6	0.705				
	OGC3	0.682				
	OGC4	0.683				
Organisational green	OGC5	0.801				
culture	OGC6	0.836	0.796	0.963	0.839	0.568
	SCA	0.861				
	SCA	0.846				
Sustained competitive	SCA	0.824				
advantage	SCA	0.771	0.847	0.866	0.896	0.682

Source: Smart PLS output (2023)

5.4.3 Convergent Validity

Convergent validity is the degree to which a construct converges to explain the variance of its items (Hair et al., 2019). In other words, how closely questionnaire items of the same construct closely relate or agree with each other. Convergent validity is established when two or more items measuring the same construct are related. Average Variance Extracted (AVE) is used to assess the convergent validity of the various indicators (Hair et al., 2019). A recommended threshold of 0.50 or higher is indicative of a strong convergent validity (Benitez, Henseler, Castillo & Schuberth, 2020; Hair et al., 2019; Fornell & Larcker, 1981), meaning that at least 50% of the variance of the measurement items that comprise the construct can be explained by the construct (Hair et al., 2021). From Table 5.3 it can be observed that sufficient convergent validity was attained because AVE values of the constructs are all higher than the 0.50 threshold.

5.4.4 Discriminant Validity

Discriminant Validity confirms that a construct is unique and distinct from other constructs in the research model (Hair et al., 2019). This establishes that two constructs in the model that are not expected to be related are indeed, unrelated. Researchers have established that Discriminant Validity can be measured using the Fornell-Larcker (1981) criterion, Heterotrait-Monotrait Ratio of correlation (HTMT), and Cross loadings (Hair et al., 2021; Hair et al., 2019, Henseler, Ringle, & Sarstedt, 2015). Table 5.4, Table 5.5 and Table 5.6 respectively show the Fornell-Larcker (1981) criterion, Heterotrait-Monotrait Ratio of correlation (HTMT), and Cross loadings results from the study.

Table 5.4: Discriminant Validity with Fornell-Larcker Criterion

	AC	AG	CAP	EGC	ET	RE	ITA	LS	OGC	SCA
Absorptive capacity (AC)	**0.754**									
Agility (AG)	0.569	**0.764**								
Capabilities (CAP)	0.399	0.468	**0.831**							
Effective GC implementation (EGC)	0.406	0.370	0.419	**0.818**						
Env. Turbulence (ET)	0.338	0.490	0.513	0.463	**0.785**					
Resources (RE)	0.440	0.290	0.641	0.536	0.586	**0.813**				
Intangible assets (ITA)	0.567	0.583	0.485	0.453	0.376	0.474	**0.866**			

Leadership style (LS)	0.577	0.626	0.265	0.392	0.385	0.288	0.550	**0.770**		
Org. Green culture (OGC)	0.379	0.316	0.054	0.337	0.278	0.258	0.459	0.669	**0.754**	
Sustained competitive adv. (SCA)	0.461	0.513	0.462	0.683	0.559	0.452	0.480	0.509	0.428	**0.826**

Source: Smart PLS output (2023)

Table 5.5: Discriminant Validity with Heterotrait-Monotrait (HTMT) Ratio

Constructs	AC	AG	CAP	EGC	ET	RE	ITA	LS	OGC	SCA	LS x EGC	OGC x EGC
Absorptive capacity (AC)												
Agility (AG)	0.714											
Capabilities (CAP)	0.500	0.589										
Effective GC implementation (EGC)	0.493	0.442	0.496									
Env. Turbulence (ET)	0.431	0.611	0.665	0.541								
Resources (RE)	0.567	0.373	0.843	0.673	0.759							
Intangible assets (ITA)	0.777	0.784	0.675	0.598	0.539	0.686						
Leadership style (LS)	0.701	0.741	0.318	0.463	0.472	0.359	0.713					
Org. Green culture (OGC)	0.475	0.416	0.172	0.378	0.273	0.283	0.524	0.784				
Sustained competitive advantage (SCA)	0.546	0.617	0.578	0.796	0.697	0.580	0.632	0.567	0.380			
Leadership style x effective GC implementation	0.242	0.173	0.309	0.426	0.235	0.303	0.163	0.111	0.116	0.298		
Org. Green culture x effective GC implementation	0.296	0.210	0.316	0.444	0.283	0.381	0.281	0.128	0.111	0.348	0.828	

Source: Author's construction

Table 5.6: Discriminant Validity with Cross-Loading

	AC	AG	CAP	EGC	ET	RE	ITA	LS	OGC	SCA	LS x EGC	OGC x EGC
AC1	0.701	0.451	0.236	0.275	0.129	0.509	0.578	0.479	0.202	0.325	-0.132	-0.161
AC2	0.772	0.508	0.279	0.285	0.229	0.536	0.581	0.429	0.252	0.386	-0.168	-0.202
AC3	0.816	0.391	0.282	0.345	0.158	0.482	0.448	0.315	0.285	0.335	-0.286	-0.314
AC4	0.774	0.416	0.394	0.324	0.385	0.344	0.287	0.125	0.510	0.376	-0.166	-0.186
AC5	0.702	0.395	0.304	0.293	0.370	0.280	0.313	0.113	0.395	0.317	-0.069	-0.141
AG2	0.465	0.819	0.311	0.309	0.264	0.404	0.479	0.216	0.196	0.386	-0.074	-0.082
AG3	0.438	0.726	0.328	0.231	0.321	0.353	0.457	0.275	0.257	0.335	-0.119	-0.091
AG4	0.558	0.775	0.320	0.230	0.263	0.502	0.604	0.338	0.115	0.383	-0.045	-0.109
AG5	0.357	0.733	0.463	0.301	0.493	0.466	0.357	0.102	0.281	0.431	-0.192	-0.275
AG6	0.389	0.764	0.354	0.317	0.491	0.493	0.519	0.303	0.242	0.409	-0.170	-0.171
CAP1	0.430	0.389	0.880	0.361	0.429	0.493	0.282	0.030	0.559	0.389	-0.265	-0.227
CAP2	0.322	0.451	0.832	0.278	0.502	0.385	0.272	0.042	0.549	0.350	-0.231	-0.220
CAP4	0.242	0.341	0.777	0.383	0.365	0.327	0.123	0.061	0.491	0.400	-0.182	-0.247
EGC1	0.340	0.278	0.411	0.869	0.437	0.389	0.324	0.228	0.496	0.636	-0.400	-0.417
EGC2	0.365	0.282	0.368	0.842	0.425	0.322	0.224	0.210	0.482	0.616	-0.385	-0.437
EGC4	0.315	0.289	0.210	0.735	0.235	0.263	0.370	0.379	0.313	0.439	-0.153	-0.139
EGC5	0.309	0.367	0.348	0.818	0.383	0.487	0.385	0.324	0.434	0.517	-0.333	-0.335

ET1	0.207	0.244	0.362	0.437	0.731	0.177	0.217	0.190	0.468	0.460	-0.294	-0.353
ET3	0.289	0.462	0.443	0.303	0.846	0.312	0.313	0.161	0.512	0.408	-0.123	-0.161
ET4	0.219	0.344	0.384	0.346	0.824	0.259	0.251	0.192	0.453	0.414	-0.188	-0.171
ET5	0.359	0.531	0.426	0.327	0.730	0.466	0.449	0.329	0.394	0.449	-0.052	-0.107
ITA4	0.474	0.507	0.457	0.377	0.455	0.855	0.378	0.262	0.489	0.382	-0.153	-0.286
ITA5	0.507	0.502	0.386	0.406	0.206	0.876	0.568	0.523	0.337	0.447	-0.077	-0.111
LS1	0.495	0.554	0.189	0.262	0.401	0.426	0.730	0.529	0.241	0.355	-0.082	-0.090
LS2	0.482	0.561	0.186	0.322	0.321	0.535	0.856	0.600	0.241	0.414	0.012	-0.052
LS3	0.392	0.502	0.276	0.291	0.416	0.488	0.809	0.521	0.244	0.425	-0.096	-0.104
LS4	0.389	0.313	0.094	0.270	0.054	0.347	0.740	0.640	0.155	0.294	-0.069	-0.024
LS5	0.480	0.513	0.308	0.409	0.225	0.414	0.770	0.434	0.280	0.465	-0.144	-0.197
LS6	0.421	0.404	0.115	0.223	0.320	0.303	0.705	0.410	0.136	0.357	-0.072	-0.081
OGC3	0.173	0.212	-0.064	0.109	-0.025	0.255	0.434	0.682	0.008	0.104	0.072	0.125
OGC4	0.246	0.144	-0.049	0.211	-0.042	0.201	0.459	0.683	0.069	0.217	-0.019	-0.006
OGC5	0.335	0.239	-0.046	0.204	0.071	0.286	0.568	0.801	0.041	0.223	-0.040	0.031
OGC6	0.327	0.303	0.145	0.345	0.451	0.483	0.548	0.836	0.375	0.487	-0.197	-0.149
RE 1	0.406	0.202	0.615	0.471	0.498	0.379	0.202	0.106	0.858	0.399	-0.278	-0.323
RE 2	0.306	0.222	0.526	0.440	0.545	0.382	0.221	0.248	0.879	0.426	-0.235	-0.304
RE 5	0.361	0.293	0.406	0.392	0.378	0.397	0.288	0.292	0.690	0.267	-0.118	-0.169

SCA1	0.407	0.396	0.408	0.643	0.434	0.386	0.490	0.418	0.374	0.861	-0.314	-0.354
SCA2	0.454	0.413	0.264	0.553	0.334	0.459	0.500	0.497	0.303	0.846	-0.214	-0.255
SCA3	0.310	0.459	0.475	0.503	0.566	0.352	0.348	0.194	0.404	0.824	-0.214	-0.255
SCA4	0.320	0.451	0.422	0.542	0.584	0.378	0.295	0.233	0.448	0.771	-0.165	-0.197
Leadership style x effective GC implementation	-0.223	-0.162	-0.272	-0.403	-0.225	-0.131	-0.100	-0.126	-0.265	-0.281	1.000	0.828
Org. green culture x effective GC implementation	-0.271	-0.197	-0.281	-0.423	-0.270	-0.225	-0.126	-0.067	-0.332	-0.328	0.828	1.000

Source: Author's construction

According to the Fornell and Larcker criterion, for discriminant validity to be achieved, a latent variable should share more variance with the indicators assigned to it than the other latent variables in the model (Hair et al., 2021). From Table 5.4, it can be observed that the highlighted variance of the latent variables is more closely associated with the indicators they have been assigned than they are with other latent variables. Therefore, it can be stated that discriminant validity has been achieved.

Hair et al. (2021) and Henseler *et al*. (2015) opined that HTMT values less than 0.9 suggest that discriminant validity is achieved. Table 5.5 indicates that discriminant validity was attained because none of the values was higher than the 0.90 threshold.

In terms of cross-loading, for discriminant validity to be achieved, the latent variables should have the highest loadings on their corresponding constructs as compared to any other constructs in the model (Hair et al., 2019). From Table 5.6 the indicator loadings for each corresponding latent variable or construct were higher as compared to other constructs, indicating that latent variables in this study have achieved discriminant validity. These implied that constructs in the model are unique and distinct from each other (Hair et al., 2019)

5.5 Structural Model Assessment

After meeting the reliability and validity criteria in the measurement of the constructs, the assessment of the structural models also known as inner models was done (Hair et al., 2017). Assessment of the structural model involved checking the relationship between the independent variables and the dependent variables of the study. Hair et al. (2019) and Hair et al. (2021) suggested five critical steps are necessary to assess the structural model in PLS-SEM. These include assessing the structural model for collinearity, significance, and relevance of relationships (significance of path coefficient), Goodness of Fit (GoF), effective size (f-square), and finally, predictive relevance (Q-square).

5.5.1 Assessing the Structural Model for Collinearity

The first step is to assess the structural model for collinearity issues. In a multiple regression analysis, multicollinearity is a measure of the degree to which several independent variables in the model correlate (Chan et al., 2022, Hair et al., 2019), leading to bias, which undermines the statistical relevance of the independent variables (Hair et al., 2021; Sarstedt & Mooi, 2019). Researchers have underscored the use of the variance inflation factor (VIF) of the independent variable to assess collinearity, explaining that a VIF threshold of five (5) or lower is required to eliminate collinearity issues (Sarstedt, Liengaard, Radomir & Ringle, 2022; Hair et al., 2019; Sarstedt & Mooi, 2019). The independent variables that meet the VIF threshold of 5 are indicative that they measure perfectly the construct under study. Table 5.7 indicates that all the independent variables had their VIF less than 5, which means there was no collinearity issue.

Table 5.7 Collinearity Statistics (Inner Model VIF)

	AC	AG	CAP	ET	RE	ITA	EGC	LS	OGC	SCA	LS x EGC	OGC x EGC
Absorptive capacity							1.825					
Agility							2.238					
Capabilities							2.026					
Environmental turbulence							1.892					
HEIs resources							2.428					
Intangible assets							1.938					
Effective GC implementation										1.456		
Leadership style										1.958		
Organisational green culture										1.893		

Sustained competitive adv.												
Leadership style x effective GC implementation										3.312		
Org. green culture x effective GC implementation										3.382		

Source: Smart-PLS output (2023)

5.5.2 Assessing the Coefficients of Determination (Goodness of Fit (GoF))

Finding the coefficient of multiple determinations (R^2) for each endogenous construct is the second step in evaluating the PLS-SEM**.** The coefficient represents the combined effects of the exogenous latent variables on the endogenous latent variable (Hair et al., 2021). This is achieved by finding the coefficient of multiple determinations (R^2) which represents the variance explained in each of the endogenous constructs by all the exogenous constructs linked to it (Lüdecke, Ben-Shachar, Waggoner and Makowski, 2021). This assessment determines the goodness of fit of the model, that is, to assess whether the model is well fitted or not fitted. R^2 values of 0.25, 0.50, and 0.75, respectively, can be used as a guide to describe weak, moderate, and considerable relationships which measures the explanatory power of the model (Ray and Harito, 2023; Hair et al., 2019). According to Hair et al. (2014), a coefficient of determination (R^2) of 0.75 is significant, indicating that the model is well-fitted. As shown in Table 5.8, the model has an R^2 value of 0.372, which indicates a moderate fit as it meant that all the exogenous variables (Resources, Capability, Intangible assets, Absorptive Capacity, Agility, Environmental turbulence) explain 37.2 % of the variance in the endogenous variable (Effective GC implementation) (Hair et al. 2021; Hair et al.; 2019). Again, from Table 5.8, the results indicate that the mediating variable (Effective GC implementation) explains 54.5% of the variance in the main endogenous variable (Universities sustained competitive advantage).

Table 5.8: R Squared

Dependent Constructs	R Square	R Square Adjusted
Effective GC Implementation	0.372	0.337
Universities Sustained Competitive Advantage	0.545	0.524

Source: Author's construction

5.5.3 Significance of Path Coefficient

The evaluation of the regression coefficients between the validated latent variable is the third step. The bootstrapping procedure is used to test the significance of indicator weights to be able to estimate standard errors from the data (Hair et al., 2021). The bootstrapping procedure provides t-values for the indicator weights and other model parameters. Using a 0.1(10%) two-tailed distribution and a large number of 5000 subsamples, a bootstrapping algorithm is executed in SmartPLS to achieve this. T-statistics (t-value) results from the bootstrapping algorithm are used to assess the direct and indirect effects of the latent variables in the model (Hair et al., 2021). With an assumption of 90% significance level, a t-value greater than 1.65 is required for the path coefficient to be significant and relevant (Hair et al., 2021). The research hypotheses have been summarized in Table 5.9.

From Table 5.9 it can be observed that, of the nine hypotheses, 3 hypotheses were supported since their t-values (7.419, 1.769, and 2.255) are above 1.65 with their corresponding P-values (0.00, 0.077, and 0.024) less than 0.1, whiles 6 of the hypothesis were unsupported.

Table 5.9 Summary of Research Hypotheses

Hypothesis	Relationship	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
H1	HEIs Resources -> EFFECTIVE GC IMPLEMENTATION	0.309	0.303	0.137	2.255	0.024	Supported
H2	Intangible Asset -> EFFECTIVE GC IMPLEMENTATION	0.163	0.160	0.092	1.769	0.077	Supported
H3	CAPABILITIES -> EFFECTIVE GC IMPLEMENTATION	-0.006	0.003	0.120	0.052	0.959	Not Supported

H4	**ABSORPTIVE CAPACITY -> EFFECTIVE GC IMPLEMENTATION**	0.093	0.103	0.099	0.937	0.349	Not Supported
H5	**AGILITY -> EFFECTIVE GC IMPLEMENTATION**	0.054	0.060	0.109	0.498	0.618	Not Supported
H6	**ENV. TURBULENCE -> EFFECTIVE GC IMPLEMENTATION**	0.166	0.170	0.121	1.373	0.170	Not Supported
H7	**EFFECTIVE GC IMPLEMENTATION -> SUSTAINED COMPETITIVE ADV.**	0.539	0.541	0.073	7.419	0.000	Supported
H8a	**ORG. GREEN CULTURE x EFFECTIVE GC IMPLEMENTATION ->**	-0.097	-0.097	0.095	1.023	0.306	Not Supported

	SUSTAINED COMPETITIVE ADV.						
H8b	**LEADERSHIP STYLE x EFFECTIVE GC IMPLEMENTATION -> SUSTAINED COMPETITIVE ADV.**	0.059	0.056	0.094	0.622	0.534	Not Supported

Source: Smart-PLS output (2023)

5.5.4 Effective Size (F-square)

Next, it is crucial to assess the effect size of each path in SEM. Effect size measures the variance in R^2 value when a specific exogenous construct is removed from the model (Hair et al., 2021). It measures whether the removal of an exogenous construct has a substantial effect on the endogenous construct(s). Generally, the exogenous latent variable has small, medium, and large effects on an endogenous variable represented by f^2 values of 0.02, 0.15, and 0.35, respectively (Cohen, 1988). After running the PLS algorithm, f^2 values were obtained which has been depicted in Table 5.10. It is evident in Table 5.10 that the exogenous constructs (environmental turbulence and intangible assets) have a medium effect on the endogenous construct (Effective GC implementation). Importantly, Resources are seen to have a large effect on Effective GC implementation while Capability, Agility, and Absorptive Capacity have small effects on the dependent variable (Effective GC implementations). Likewise, Effective GC implementation and Leadership style have a significant effect on Universities' sustained competitive advantage.

Table 5.10: F-square Effect Size

Constructs	**Effective Green Computing Implementation**	**Universities Sustained Competitive Advantage**
Resources	**0.063**	
Intangible assets	**0.022**	
Capability	0.00	
Agility	0.002	
Absorptive Capacity	0.007	

Environmental Turbulence	**0.023**	
Effective GC Implementation		**0.438**
Leadership Style		**0.056**
Org. Green Culture		0.011

Source: Author's construction

5.5.5 Predictive relevance (Q-square)

The final evaluation is the model's predictive power, which is based on the Stone-Geisser Q^2 statistic (Geisser, 1975; Stone, 1974). The predictive relevance of each independent variable suggests that the research model should be able to predict "new or future observations" of the dependent variable indicators (Hair & Sarstedt, 2021; Chin et al., 2020). In other words, it gives a measure of how well the path model can predict the originally observed values (Shmueli et al., 2019, Shmueli et al., 2016). According to Hair et al. (2021), predictive relevance can only be done for reflective endogenous variables or constructs. It is worth noting that, some researchers admittedly use the R^2 as a determinant for a model's predictive power. However, Hair et al. (2021) opined that this is an incorrect interpretation. They explained that R^2 is indicative of the "model's in-sample" explanatory power and not its "out-of-sample" predictive power (Hair & Sarstedt, 2021; Chin et al., 2020). The "blindfolding-based cross-validated redundancy measure q2" with recommended values ($0.02<Q^2<0.15$, $0.15<Q^2<0.35$, above 0.35) is used to measure the predictive relevance of the model as either weak, medium or strong (Hair et al., 2021; Abu et al., 2021). In Smart PLS-4, which was used for the study's data analysis, blindfolding is conducted using the PLS-Predict menu. To determine q^2, a PLSpredict algorithm was run (Shmueli et al., 2019).

The results of the test are as shown in Table 5.11, it is seen that EGC1, EGC2, EG5, SCA1, SCA2, SCA3, and SCA4 have moderate predictive relevance as compared to EGC4 that has weak predictive relevance. This implied that the study's model has a moderate predictive relevance.

Table 5.11: Predictive Power Q^2 (MV prediction summary)

	Q^2predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE
EGC1	0.209	0.797	0.618	0.889	0.691
EGC2	0.193	0.751	0.601	0.872	0.680
EGC4	0.063	0.800	0.643	0.965	0.722
EGC5	0.212	0.755	0.604	0.895	0.720
SCA1	0.280	0.846	0.645	0.936	0.745
SCA2	0.284	0.916	0.727	1.082	0.858
SCA3	0.216	0.813	0.643	0.861	0.680
SCA4	0.227	0.835	0.658	0.954	0.738

Source: Smart-PLS output (2023)

Another measure of predictive relevance is the use of LV prediction summary (Hair et al., 2021), which displays the Q^2 predict values in Table 5.12. From Table 5.12, it is observed that Effective GC implementation has moderate predictive relevance (0.276), whereas Universities Sustained competitive advantage has strong predictive power (0.378).

Table 5.12: Predictive Power Q2 (LV prediction summary)

	Q^2predict	RMSE	MAE
EFFECTIVE GC IMPLEMENTATION	0.276	0.883	0.676
SUSTAINED COMPETITIVE ADV.	0.378	0.804	0.623

Source: Smart-PLS output (2023)

5.6 Effects of Moderating Variables

For this study, the moderating variables (leadership style and organisational green culture) are continuous as they moderate the relationship between only particular constructs and not the entire model (Memon, Cheah & Ramayah, 2019). For this reason, a simple slope analysis (standard moderation) and not multi-group analysis (Memon et al., 2019) was done in other to assess whether leadership style and organisational green culture strengthen or weaken the relationship between Effective GC Implementations (mediating variable) and Universities Sustained Competitive advantage (dependent variable). A simple slope analysis is run to test the statistical significance differences between the various group models (Cheah, Thurasamy, & Memon, 2020). P-values of less than 0.05 are the recommended threshold to conclude that a moderating variable has a significant impact on the relationship between two constructs (Memon et al., 2019; Hair et al., 2019). The results of the simple slope analysis are shown in Table 5.13, Figure 5.5, and Figure 5.6.

Table 5.13: Moderation Analysis

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
LEADERSHIP STYLE x EFFECTIVE GC IMPLEMENTATION -> SUSTAINED COMPETITIVE ADV.	0.059	0.056	0.094	**0.622**	**0.534**
ORG. GREEN CULTURE x EFFECTIVE GC IMPLEMENTATION -> SUSTAINED COMPETITIVE ADV.	-0.097	-0.097	0.095	**1.023**	**0.306**

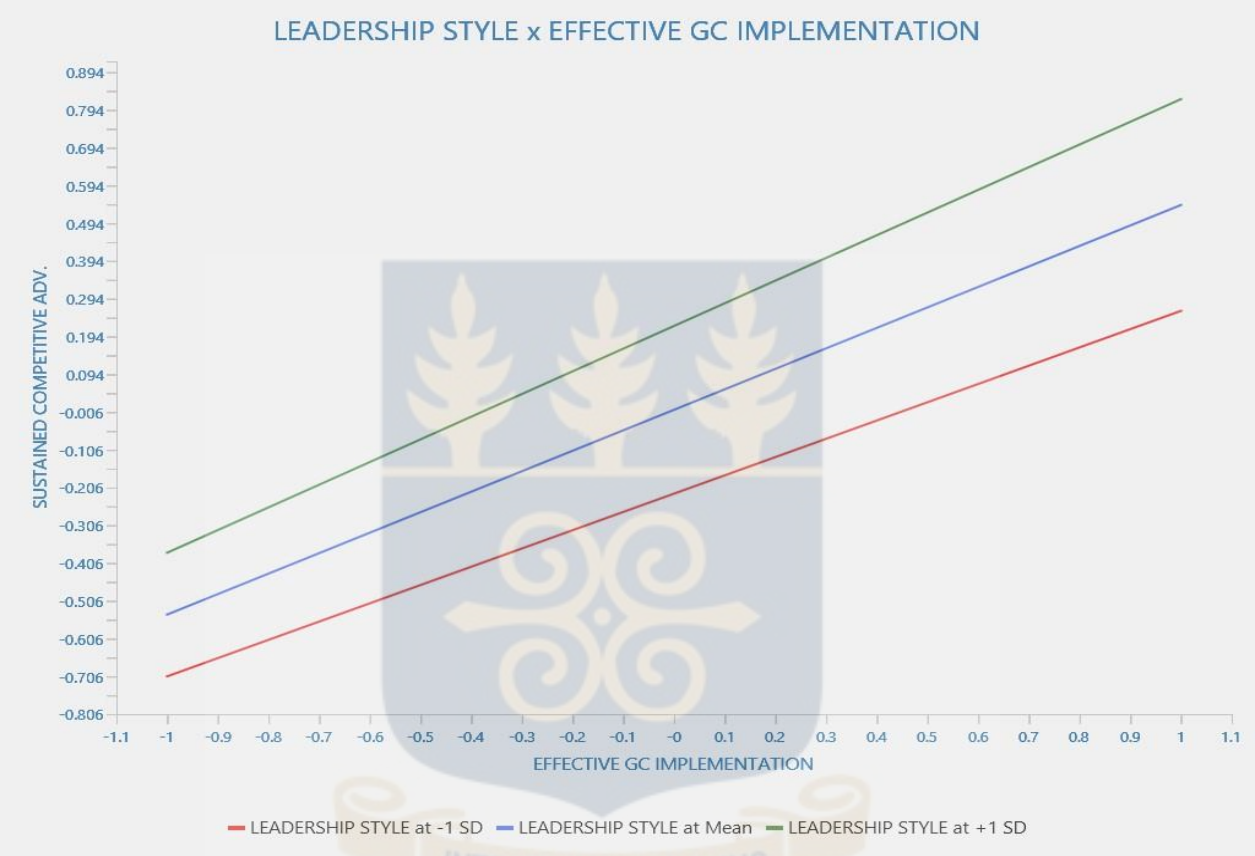
Source: Smart PLS output (2023)

5.6.1 Leadership Style

From Figure 5.13, it can be seen that the p-values highlighted are more than 0.05, which indicates that leadership style does not significantly moderate the relationship between Effective GC Implementation and Universities' sustained competitive advantage. This implies that leadership style does not have a substantial effect on how effective GC Implementation influences the competitive advantage of universities.

Essentially, the impact of effective GC Implementation on sustaining a competitive advantage remains consistent regardless of the leadership style.

Figure 5.5 Simple slope analysis for Leadership style



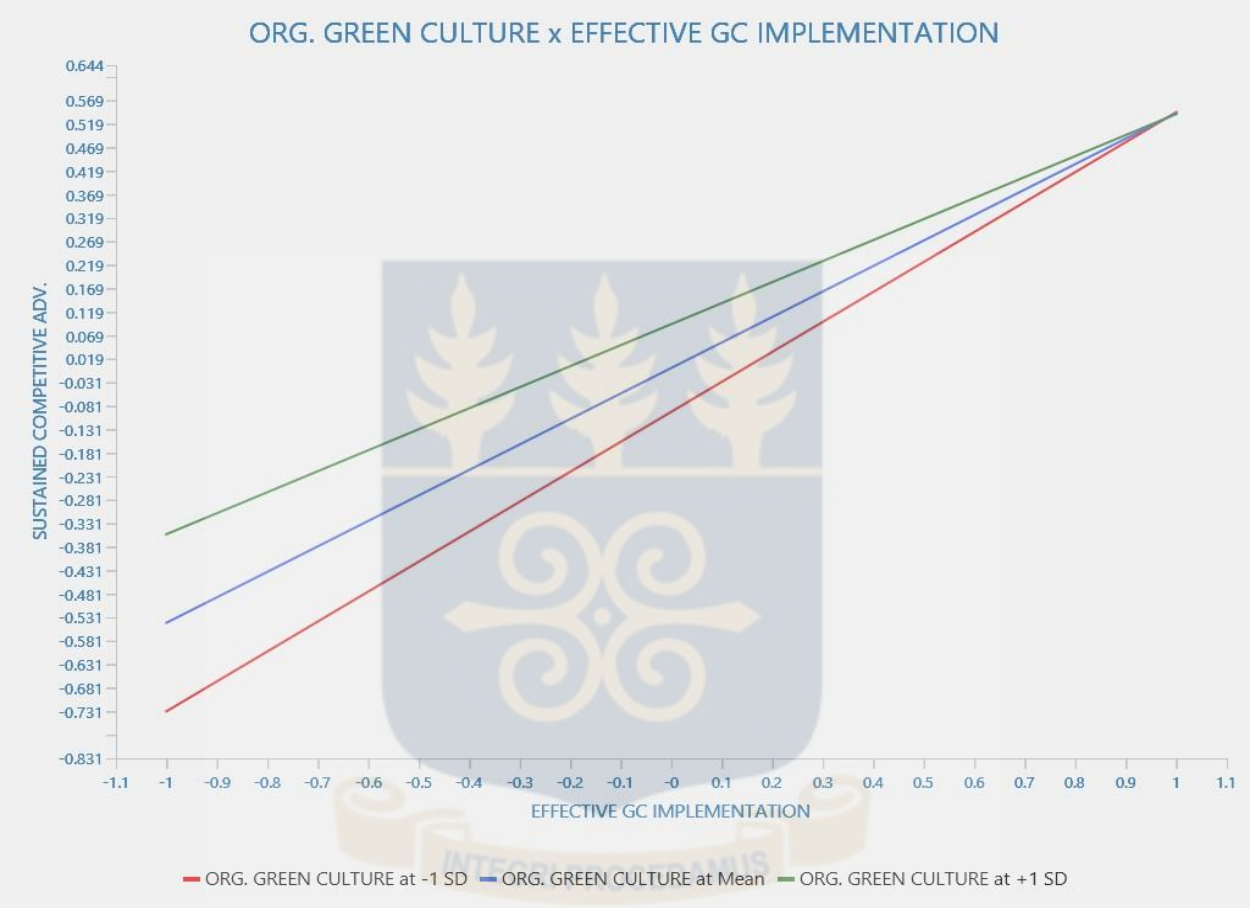
Source: Smart PLS output (2023)

5.6.2 Organisational Green Culture

From Figure 5.6, it can be seen that the p-values highlighted are more than 0.05, which indicates that organisational green culture does not significantly moderate the relationship between effective GC implementation and Universities' sustained competitive advantage. This implies that the influence of effective GC implementation on sustained competitive advantage is consistent regardless of the level of organisational green culture.

In other words, the benefit derived from implementing GC practices does not depend on how strong or weak the organisational green culture is.

Figure 5.5 Simple Slope Analysis for Organisational Green Culture



Source: Smart PLS output (2023)

5.7 Chapter Summary

This chapter aimed to present the findings and analysis in other to achieve the research objectives in Chapter One. In this chapter, a detailed analysis of the questionnaire data collected from the different universities across Ghana on their GC initiatives was done. The analysis of the data helped to identify the current state of GC implementations in HEIs in Ghana, the factors that drive GC implementation effectiveness, and how universities sustain competitive advantage through their GC initiatives. In addition, the moderating effects of leadership style and organisational green culture on the relationship between EGC implementation and Universities' SCA was also analyzed in this chapter.

CHAPTER SIX

DISCUSSION OF RESULTS

6.1 Chapter Overview

The previous chapter primarily focused on documenting the findings of the study. This section discusses the main findings of the study based on the study objectives that were proposed in Chapter One and the hypotheses developed based on the research framework in Chapter Three. The chapter is divided into four sub-sections reflected in the four research questions and the constructs in the conceptual framework.

Firstly, an assessment of the current state of GC implementations in HEIs. Secondly, an assessment of the factors that are necessary for effective GC implementations in HEIs. Thirdly, how effective GC implementation leads to universities' sustained competitive advantage, and finally to assess the moderating effects of organisational culture and leadership style on the relationship between effective GC implementation and Universities Sustained Competitive Advantage.

6.2 Addressing the Research Questions

6.2.1 Current State of Green Computing Implementations in HEIs in Ghana

Research objective one was to assess the current state of GC implementation in Ghanaian Universities. The current state of GC implementations in HEIs is summarized in Table 6.1 based on the findings in Chapter 5, section 5.2.

Table 6.1: Current State of Green Computing Implementations

State	**Highly Implemented**	**Least Implemented**
GC Initiatives Implemented in HEIs	E-learning portals, Energy-efficient appliances, Institutional Email systems, Electronic pay-slip, Cloud computing, Online admission processes, Online examinations, Thin client computers and Energy-efficient Data centers	Green policy, green strategy, sustainability champions, E-waste recycling; Green procurement, Green awareness and training
Familiarity with GC	**Yes** **86.5%**	**No** **13.5%**
GC importance to HEIs	**Yes** **83.5%**	**No** **16.5%**

Explicit and vigorous commitment to GC Implementation	**Yes** **30.4%**	**No** **35.7%**	**Not Sure** **33.9%**

Source: Author's constructs based on study findings

In Table 6.1, the analysis of GC initiatives revealed a mixed picture regarding their implementation and perceived importance. Comparative to Paul et al. (2023) and Nyabuto (2024)'s detailed review of articles on GC, this study identified several notable GC initiatives, including the use of e-learning portals (Green education), energy-efficient appliances, institutional Email systems, Electronic pay-slip, Cloud computing, online admission processes, online examinations, thin client computers, and energy-efficient data centers. It is important to note that Green policy, green strategy, sustainability champions, E-waste recycling; Green procurement, Green awareness, and training were among the least implemented GC initiatives in the sampled Universities in Ghana. The findings also revealed that a satisfactory number of respondents (115) from the sampled universities are familiar with GC concept with an appreciable number (18) of technical employees who were not familiar with the GC concept. In addition, the majority of the study's respondents acknowledged that the implementations of GC at the sampled universities often lack explicit commitment and support from management (Chapter 5, section 5.2). The findings suggest that the limited implementation of comprehensive green policies, the absence of sustainability champions, and minimal green awareness training are indicative of a broader lack of commitment from the respective university management. The high-perceived lack of commitment by management of these HEIs on GC initiatives among respondents reflects the insufficient emphasis placed on environmental sustainability by top management, which ultimately affects the depth and effectiveness of the implemented initiatives. This is consistent with the findings in studies conducted by Ram et al. (2023) and Ahmed (2018) that top management support and commitments, in the form of providing funding, allocating resources, and developing action plans for GC implementation are needed for GC implementation to be successful.

6.2.2 Effectiveness of Green Computing Implementation in Ghanaian Universities

Research objective two was to assess the implementation effectiveness of GC in Ghanaian Universities. Based on the conceptual framework, six factors were considered important for GC implementations to be effective in HEIs. These are Resources, Intangible Assets, Capability, Agility, Absorptive Capacity and Environmental Turbulence. Of the six hypotheses developed, two were supported, and four were otherwise.

The results showed that the Resources of HEIs significantly influence Effective GC implementation in Universities in Ghana ($\beta = 0.309$, $p < 0.1$). This indicates that the study's respondents agreed that their respective HEIs have been successful in identifying and providing necessary resources, such as physical and technological infrastructure for effective GC implementations. Additionally, they acknowledged the willingness of top managers to allocate these resources for the success of GC implementations. This substantiates the findings of Chen et al. (2019) and Daft (2015) that adequate resources are necessary for successful GC implementation. Nason and Wiklund (2015) make a related confirmation that available resources with their special characteristics are sources for creating distinctive skills for organisational growth. Extant studies have supported the study's finding that firms' ability to combine ordinary resources makes them unique to achieve greater performance and competitive advantage (Asadi et al., 2021; Bozic & Dimovski, 2019; Kraja, 2018; Asharaf & Mueller, 2015). The results support the hypothesis (H1) that HEIs resources positively influence effective GC implementation.

The second hypothesis aimed to assess whether intangible assets such as environmental sustainability values, documented policies and strategies, reputations, and green procurement standards, positively influence effective GC implementation in HEIs. The respondents indicated that their institutions value environmental sustainability and conform to industry standards when procuring computing and other electronic devices (E.g.; EPA's Energy Star

ratings). Based on the path estimation, the results showed that HEIs intangible assets have a significant influence on Effective GC implementation in Universities in Ghana ($\beta = 0.163$, $p < 0.1$). This result confirms the finding of Kraja (2018), Haskel and Westlake (2022), and Cucculelli and Bettinelli (2015) that intangible assets are increasingly important for firm growth, value creation, and competitiveness. Therefore, the result supports the hypothesis (H2) that HEIs intangible assets positively influence effective GC implementation in Ghana.

The third hypothesis (H3) was to determine that HEIs capabilities positively influence effective GC implementation. The results showed that the Capabilities of HEIs do not have a significant effect on Effective GC implementation in Universities in Ghana, based on the path estimation ($\beta = -0.006$, $p > 0.1$). This is in contrast with Parida et al. (2016) study, which suggested that ICT capabilities are important enablers to the performance and competitive advantage of a firm. In addition, this finding disagrees with that of Galliers (2011), who claimed that an organisation's capability and competencies to put a commoditized IT or ICT to good use is crucial and plays a role in strategically positioning the firm over its competitors. The result fails to support the hypothesis that HEIs capabilities relate positively to effective GC implementation.

The fourth hypothesis was to determine where Absorptive Capacity positively influences effective GC implementation. Based on the path estimation, the results showed that Absorptive Capacity does not have a significant effect on Effective GC implementation in Universities in Ghana ($\beta = 0.093$, $p > 0.1$). This finding is in contrast with Lane et al. (2006) who argued that firms with AC can learn from best practices and innovations in other organisations and industries and apply them to their context. This is also inconsistent with the findings of Song et al. (2021), Khan et al. (2020), and Leiponen and Helfat (2010) who found that firms' survival and continuity largely depend on their ability to acquire new information (AC) needed for business innovation and competitive advantage. This implies that respondents agreed that their

respective HEIs cannot acquire, assimilate, and apply knowledge and technology from external sources to be effective at implementing GC practices (Song et al.; 2021; Cohen & Levinthal, 1990). The results fail to support the hypothesis (H4) that HEIs Absorptive Capacity relates positively to effective GC implementation.

The fifth hypothesis was to determine where Agility positively influences effective GC implementation. Based on the path estimation, the results showed that Agility did not have a significant effect on Effective GC implementation in Universities in Ghana ($\beta = 0.054$, $p > 0.1$). This implied that the sampled HEIs lacked the ability to respond quickly and flexibly to changes in the sustainability landscape which is necessary for effective GC implementation. The finding of the study is consistent with that of Nurjaman et al. (2021) recognizing that strategic agility implementation improves firms' performance. Likewise, the finding substantiates those of other researchers such as Giesenbauer and Müller-Christ (2020) and Aleixo et al. (2018).

Finally, the sixth hypothesis was to determine whether ET relates negatively to effective GC implementation. Based on the data analyzed, ET did not have a significant effect on Effective GC implementation in Universities in Ghana ($\beta = 0.166$, $p > 0.1$). This finding suggests that contrary to the expectations based on theoretical discussions (Zhou et al., 2019; Song et al., 2021), ET may not have a direct detrimental effect on the success of GC initiatives in this context. The results failed to support the hypothesis that High ET negatively influences effective GC implementation in HEIs.

6.2.3 Impact of Green Computing Implementation Effectiveness on Universities' Sustainable Competitive Advantage

The analysis of the third research objective, aimed at evaluating the impact of effective GC implementation on the sustainable competitive advantage of universities, reveals a significant positive relationship. Specifically, the results demonstrate that effective GC implementation substantially contributes to enhancing the universities' sustained competitive advantage, with a path coefficient (β) of 0.539 and a p-value less than 0.1. This indicates that the study's respondents agreed that GC initiatives support our University's core competencies enabling it to exploit market opportunities and neutralize competitive threats. It was also indicative that GC has enhanced their Universities' recognition and reputations in terms of environmental sustainability. This finding underscores the strategic value of integrating GC practices within HEIs highlighting their potential to not only foster environmental sustainability but also to strengthen competitive positioning in the academic landscape (Mataruka, 2022; Singjai et al., 2018; Purwanti, 2022; Uddin et al., 2017; Fraj et al., 2015; Leonidou et al., 2013). This finding is coherent with Setiadi et al. (2018) that GC implementation has a positive correlation with competitive advantage in the education industry. Similarly, Dao, Langella, and Carbo (2011) opined that GC implementation could influence the value of competitive advantage.

6.2.4 Effects of Moderators

The section explores how moderators positively or negatively influence the relationship between the independent variables and the dependent variable. Two moderator constructs were adopted for this study: namely, organisational Green culture and Leadership style. Several studies had suggested that the culture and leadership style adopted in an organisation have a significant impact on the adoption and implementation of technology (Abbas & Khan, 2023; Wang et al., 2022). Specifically, Abbas and Khan (2023) admonished that culture is a vital resource for understanding the connection between green knowledge management, green

performance, and innovation. Others have also over-emphasized the influence of culture and the style adopted by top management on the future green success or competitiveness of the organisation (Muisyo et al., 2022; Banini et al., 2021; Nadeem et al., 2017). It was, therefore, necessary to ascertain the extent to which these factors moderate the correlation between effective GC implementation and Universities sustained competitive advantage.

6.2.4.1 The Effect of Organisational Green Culture

First, it was hypothesized that Organisational Green Culture positively moderates the relationship between effective GC implementation and Universities' sustained competitive advantage. The results showed that Organisational green culture did not significantly moderate the relationship between Effective GC implementation in Universities in Ghana ($\beta = 0.059$, $p > 0.1$). This is in contrast with the study by Galpin et al. (2015) who identified that organisational green culture leads to effective implementation of green practices and behavior enabling firms to gain competitive advantage. In a like manner, the finding is incoherent with that of Abbas and Khan (2023) who recognized that green culture strengthens the relationship between green knowledge management and organisational green innovation.

6.2.4.2 The Effect of Leadership Style

Second, it was hypothesized that leadership style positively moderates the relationship between effective GC implementation and Universities' sustained competitive advantage. However, the findings indicated that leadership style does not significantly influence the relationship between effective GC implementation and Universities' sustained competitive advantage ($\beta = -0.097$, $p > 0.1$). However, this finding is inconsistent with that of Özgül and Zehir (2022) who found that top management's green transformational leadership positively influences green organisational learning capability, which has a positive indirect effect on competitive advantage.

Similarly, the finding is inconsistent with a study by Sun (2002), who identified that leadership style has a significant positive relationship with organisation performance in schools and enterprises.

6.3 Chapter Summary

This chapter looked into detailed the relationship that existed between the independent variables and the main dependent variable. The chapter discussed the main research findings reflected in the four research objectives of the study according to the hypothesis developed from the research conceptual framework. The first and second sections of the chapter sought to assess the implementation effectiveness of GC in Ghanaian Universities and the impact of effective GC implementation on Universities' sustainable competitive advantage. The last part of the chapter discussed the influence of organisational green culture and leadership style on universities' sustained competitive advantage through their ability to implement GC effectively. This enabled the researcher to give future recommendations concerning the factors that need to be improved to ensure effective GC implementations in HEIs in Ghana.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Chapter Overview

The previous chapters have focused on the introduction, literature review, theoretical review, methodology, analysis, and discussions of the findings of the study. The study assessed and identified the factors needed for effective GC implementation in HEIs based on the constructs in the DC and RBT. However, this chapter further provides a summary concluding the study and presents the study's contributions and implications to research, practice, and policy.

The chapter begins with a review of the research objectives indicated in Chapter One and thoroughly reveals how these objectives and questions have been addressed. In addition, the chapter presents a discussion of the contribution this study adds to the research knowledge. The chapter delves into the limitations of the study and gives directions for future research pointers in the concluding part of this chapter.

7.2 General Summary of the Study

The study aimed to assess the implementation effectiveness of GC in Ghanaian Universities and explore its impact on Universities' sustainable competitive advantage. The research process was structured systematically across the chapter as follows:

Chapter 1: Introduction

Research Background: Provided an overview of GC, its relevance in HEIs, and the context of its implementation in Ghanaian universities.

Problem Statement: Defined the key issues regarding the effectiveness of GC initiatives and their roles in enhancing universities' sustainable competitive advantage.

Research Objectives: Outlined the main objectives, including evaluating the extent of GC implementation and its impact on sustainability. The study explicitly sought to achieve the following objectives:

1. Assess the current state of GC implementation in Ghanaian Universities,
2. Determine the factors that account for effective GC implementation in universities in Ghana
3. Assess the impact of GC Implementation effectiveness on universities' sustainable competitive advantage
4. Assess the moderating effects of organisational culture and leadership style on the relationship between GC implementation effectiveness and universities' sustainable competitive advantage.

Research Questions and Hypotheses: This section formulated the central research questions and hypotheses to guide the study. To achieve these four objectives**,** nine hypotheses were formulated, and questionnaires were adopted to collect data from respondents in the various universities in Ghana**.** The constructs from the conceptual framework were tested using their indicator loadings (Hair et al., 2021) whereas hypotheses were tested using the path coefficient for significations (Hair et al, 2021) and the results were discussed accordingly.

Significance of the Study: Highlighted the importance of the study in contributing to academic, policy, and practical applications for universities.

Chapter 2 conducted a comprehensive literature review, examining theoretical frameworks and previous research to identify gaps and inform the study.

Chapter 3 detailed the research framework. The RBV and DC theories underpinned the study based on the gaps identified and the justification for their adoption in a thorough literature review process.

Chapter 4 detailed the research methodology, including the design, data collection methods, sampling procedures, and data analysis techniques.

Chapter 5 presented the findings, highlighting the extent of GC implementation and analyzing respondents' views on its importance to existing literature, exploring their practical implications, and addressing challenges and limitations.

Chapter 6 discussed the key findings of the study based on the study objectives and hypothesis.

Finally, Chapter 7 provided an overarching summary, reflecting on the study's overall contributions and significance. In addition, it offered recommendations for improving GC practices and suggested directions for future research.

7.3 Summary of the Research Findings

The major findings, as they related to the specified objectives and questions of the study have been summarized into four subsections. First, the findings on the current state of GC implementations in HEIs in Ghana. Second, the findings on the effectiveness of GC implementations in HEIs in Ghana. Third, the findings on how effect GC implementation leads to sustainable competitive advantage in universities in Ghana. Lastly, the findings on what positively or negatively influences the relationship between effective GC implementations and sustained competitive advantage in Universities in Ghana.

Table 7.1: Status of Hypotheses

No.	Hypothesis	Status
H1	HEIs resources positively influence effective GC implementation.	Supported
H2	HEIs intangible assets positively influence effective GC implementation.	Supported
H3	HEIs capabilities positively influence effective GC implementation.	Not supported
H4	HEIs Absorptive capacity positively influences effective GC implementation	Not supported
H5	HEIs Agility positively influences effective GC implementation	Not supported
H6	High ET positively influences effective GC implementation in HEIs	Not supported
H7	Effective GC implementation positively influences universities sustained competitive advantage.	Supported
H8a	HEIs OGC positively moderates the relationship between effective GC implementation and Universities' sustained competitive advantage.	Not supported
H8b	HEIs LS positively moderates the relationship between effective GC implementation and Universities' sustained competitive advantage.	Not supported

Source: Developed by the author from study findings

Table 7.2: Summary of Research Findings

Research Purpose: To assess the implementation effectiveness of GC in Ghanaian Universities and its impact on universities sustainable competitive advantage.			
Research objective	**Research findings**	**Extant literature**	**Contributions, implications, and recommendation**
1. To assess the current state of GC implementation in Ghanaian Universities	1. The findings reveal that most universities in Ghana are well-informed about the concept of GC. However, many technical employees at these universities lack familiarity with GC. 2. The findings indicate that many respondents believe green	Nyabuto (2024); Paul et al. (2023); Ram et al. (2023)	The research has shed light on the familiarity, awareness level and importance of GC in universities in Ghana. This study adds to the literature on GC identifying the common GC initiatives in universities in Ghana.

	GC initiatives have little relevance to their university's operations due to a lack of strong commitment to energy efficiency and environmental sustainability from top management. 3. The study identified that a diverse range of GC initiatives have been implemented in public and private universities in Ghana. 4. Notable among them are E-learning portals, energy-efficient appliances use, institutional Email use, Electronic pay-slip,		The researcher recommends the development of clear strategic goals, integrating GC into institutional policies, increasing awareness through training, and fostering a culture of sustainability in the education landscape in Ghana. The study serves as foundational ground for future research to focus on evaluating the effectiveness of the outline GC and their contribution to sustainability and competitive advantage in other sectors.

	Cloud computing, online admission process, online examinations, thin client computers, and energy-efficient data centers. 5. Findings also reveal that critical aspects of GC implementation such as the development of green policy, the formulation of a green strategy, the appointment of sustainability champions, E-waste recycling, green procurement practices, and the promotion of green awareness and training were less		

	commonly adopted within the universities sampled.		
2. To assess the implementation effectiveness of GC in Ghanaian Universities	1. The study reveals that resources play a critical role in facilitating effective GC practices, significantly influencing the implementation's success. 2. The results further revealed that for GC implementation to be effective in HEIs, top managers of universities should prioritize the allocation and efficient use of resources to facilitate effective GC implementation and	Ram et al. (2023); Liang et al. (2022); Turek et al. (2021); Ahmed (2018)	The study fills research gaps by evaluating the effectiveness of GC initiatives in Ghana's educational sector, focusing on their success post-adoption and providing insights from the perspective of underdeveloped countries, which has been largely overlooked in existing literature. The adopted research theories provide valuable data for research studies aimed at understanding the impact of sustainability practices

	strategically invest in them to be better positioned to lead their universities towards sustainability. 3. The study underscored that Leadership commitment, resource allocation, and strategic investment are crucial for effective GC implementation in HEIs in Ghana. 4. Top management support is crucial in the early stages of green implementation in other to mobilize organisational		in institutions in terms of the critical resources and capabilities needed to support the GC implementations. Top managers of Universities in Ghana and other jurisdictions can use the findings to strategically plan and implement GC initiatives. This includes adopting best practices identified in the study, tailoring GC strategies and policies to their unique contexts, and creating a roadmap for a sustainable technology environment.

	resources in developing and implementing green strategies		
3. To assess the impact of GC implementation effectiveness on universities' sustainable competitive advantage	1. The findings highlighted that using the distinct resources of the organisation influences the effectiveness of GC implementation, which significantly contributes to attaining a sustained competitive advantage for universities in Ghana that adopt and implement these GC initiatives. 2. Implementing GC effectively can lead to cost savings, enhanced reputation, and	Purwanti (2022) ; Mataruka (2022); Setiadi et al.(2018); Uddin et al. (2017)	Top management of universities in Ghana should continuously enhance and update their resources to meet the increasing demands of environmental groups and government regulations, thereby reducing their environmental impact. This study arguably contributes to the knowledge gap by being the first to assess the effectiveness of GC implementation on competitive advantage of

	compliance with environmental regulations, ultimately benefiting the universities and society. 3. The result emphasizes the strategic importance of effective GC initiatives in HEIs do not only foster environmental sustainability but also strengthen competitive positioning in the academic landscape.		universities within a developing economy like Ghana. The researcher recommends that university top managers secure copyrights and intellectual property rights for their GC initiatives to protect their unique capabilities and resources from replication by other institutions.
4. To assess the moderating effects of organisational culture and leadership style on the relationship between GC implementation effectiveness	1. The study's outcome revealed that the leadership style of top management and the organisational green culture of the stakeholders of the	Abbas and Khan (2023); Wang el al. (2022); Özgül and Zehir (2022)	The study serves as foundational ground for future research to explore further the effects of OGC and leadership style on the

and universities' sustainable competitive advantage	universities do not significantly alter the impact of effective GC implementation on the universities' ability to maintain a sustained competitive advantage. 2. This suggests that while effective GC practices are crucial for enhancing competitive positioning, the impact of leadership approaches and the prevailing green culture within these institutions on this dynamic is minimal. 3. This also suggests that the influence of organisational		relationship between GC and competitive advantage.

	culture on enhancing competitive advantage through GC initiatives may require further investigation to understand their roles fully.		

Source: Author's construction based on research findings

7.4 Implications of the Study

Just as the research significance proposed in the beginning Chapter of the study, the findings of the study have remarkable implications in the area of practice, research, and policy.

7.4.1 Research Implications

This study addresses existing gaps by evaluating the effectiveness of GC initiatives after their adoption, with a particular focus on assessing their success in the educational sector within Ghana. The research was guided by DC and RBV theories, which were instrumental in explaining the findings.

DC theory provided a framework for understanding how universities adapt and leverage their GC initiatives to respond to changing environmental conditions and technological advancements. The theory helped explain how institutions develop and refine their capabilities to achieve and sustain competitive advantage through GC practices. By focusing on the dynamic aspects of capability development, the study shed light on the processes through which universities enhance their GC initiatives over time.

On the other hand, the Resource-Base View theory analyzed how universities utilize their internal resources and capabilities to implement effective GC initiatives. RBV emphasized the importance of valuable, rare, inimitable, and non-substitutable resources in achieving a sustainable competitive advantage. The theory thus helped identify critical resources and capabilities needed for the successful adoption and implementation of GC initiatives and its contribution to the overall competitive advantage and sustainability of educational institutions, particularly in Ghana.

Researchers and scholars can build upon findings to identify trends, develop new sustainability models, and deepen the understanding of sustainable practices in the GC concept within educational settings. It also provides valuable data for research studies aimed at understanding the impact of sustainability practices in institutions.

Additionally, the study's focus on the Ghanaian context offers insights into the generalizability of GC practices across diverse cultural and economic settings. By applying the principles of DC and RBV theories, researchers in other regions could draw comparisons or use similar methodologies to assess the effectiveness of sustainability initiatives in their local contexts.

7.4.2 Practical Implications

The study highlighted areas where university management may need to provide additional training or support for technical staff and faculty members in the implementation and sustainability of GC initiatives. From these, the implementing universities can develop targeted capacity-building programs to enhance the skills and knowledge necessary for sustainable technology adoption, implementation, use, and sustainability of GC implementations.

Additionally, universities in Ghana can use the findings to strategically plan and implement GC initiatives. This includes adopting best practices identified in the study, tailoring GC strategies and policies to their unique contexts, and creating a roadmap for a sustainable technology environment.

7.4.3 Policy Implications

In terms of policy, the study identified that holistically, GC implementations in universities is not backed by green policy and strategies. Policymakers in Ghana's HEIs could use the study findings to make informed decisions regarding the integration of GC policies within HEIs. It could highlight areas of success and areas that may need additional attention, guiding the development of policies that promote sustainability.

Again, using the RBV and DC theories, the study has shed light on the resource and capabilities requirements needed for successful GC implementation in Ghanaian HEIs. This information can aid policymakers in allocating resources efficiently, ensuring that universities have the necessary resources and capabilities that suit the rapidly changing environment for sustainable technology practices in the educational sector in Ghana.

7.5 Limitations and Recommendations for Future Research

This study, while providing valuable insights, has certain fundamental limitations that should be acknowledged. The following points outline these constraints and offer recommendations for future research directions:

Firstly, the study utilized a quantitative approach, which provided important data on the effectiveness of GC initiatives. However, integrating qualitative data through methods such as interviews could offer deeper contextual insights and enrich the understanding of the phenomena studied. Future research could benefit from employing qualitative or mixed-method approaches to complement quantitative findings from this study and provide a more nuanced perspective on how GC practices impact competitive advantage in universities. Exploring the moderating effects of organisational green culture and leadership styles on GC implementation could be particularly insightful.

Secondly, the research was conducted exclusively within Ghanaian universities, which may limit the generalizability of the findings to other regions or sectors. Future studies could expand the scope to include different sectors such as healthcare, manufacturing, or government organisations, to assess how GC practices are implemented and their effects in various contexts. This broader perspective could enhance the understanding of GC's applicability and impact across diverse organisational settings.

Additionally, the study highlighted emerging GC trends in Ghanaian universities, including cloud computing, virtualization, paperless initiatives (online examinations and admissions), electronic learning, and mobile-enabled learning. Future research could focus on evaluating the effectiveness of these specific GC initiatives outlined in this study and their contribution to sustainability and competitive advantage in other sectors. Examining these trends in other sectors or regions could provide further insights into the evolving practices and benefits of GC.

In summary, while this study provides significant contributions to understanding GC in Ghanaian universities, expanding research efforts to include qualitative methods, diverse sectors, and specific GC initiatives could offer more comprehensive insights and strengthen the generalizability of the findings.

7.6 Conclusion

This research set out to evaluate the effectiveness of GC implementation in Ghanaian universities and its impact on their sustainable competitive advantage. Through a detailed literature review, it was evident that although GC concept has attracted interest from different researchers, particularly in the education sector, the effectiveness of its implementation was lacking in recent literature. The study aimed to fill this scarcity gap to provide insights into the current state of GC practices, their effectiveness, and their contributions to universities' competitive positioning using the RBV and DC theories.

The study's originality lies in its position as one of the few, if not the first in Ghana, to assess the effectiveness of GC implementation from the perspective of HEIs through the lens of RBV and DC theories.

The study found that while Ghanaian universities are generally knowledgeable about GC, there is a notable lack of familiarity with GC among many technical employees. The commitment to green initiatives from top management is weak, which affects the relevance and implementation of GC practices. Common GC initiatives observed include e-learning portals, energy-efficient appliances, and cloud computing. However, critical elements such as green policy development and e-waste recycling were less commonly adopted.

The research highlighted that effective GC practices are heavily dependent on resource allocation and leadership support. Successful implementation requires top management to prioritize resource investment and demonstrate commitment to sustainability. The study underscores that leadership and strategic resource management are essential for effective GC practices.

It was also found that effective GC implementation contributes significantly to a university's competitive advantage by leading to cost savings, enhanced reputation, and compliance with environmental regulations. The study emphasizes that well-implemented GC initiatives not only support environmental sustainability but also strengthen the universities' positions within the academic landscape.

The findings indicate that organizational culture and leadership style have minimal influence on the relationship between GC implementation effectiveness and competitive advantage. This suggests that while effective GC practices are crucial, the role of organizational culture and leadership in enhancing competitive advantage through GC needs further exploration.

The study also indicated that Ghanaian universities should develop clear strategic goals for GC and integrate these into institutional policies. It also admonished increased awareness through targeted training and a stronger commitment to sustainability from top management is crucial.

The research pointed out that effective GC implementation requires a strategic approach to resource allocation and investment as such universities should focus on mobilizing resources and adopting best practices tailored to their specific contexts to support sustainability. The findings further revealed that universities should leverage their unique GC capabilities to secure competitive advantages, such as by protecting intellectual property related to their GC initiatives.

The study provides a foundation for future research on the role of organizational culture and leadership in enhancing the impact of GC initiatives. Further investigation could offer deeper insights into how these factors influence competitive advantage.

Overall, this research contributes to the understanding of GC practices in the context of Ghanaian HEIs and provides actionable recommendations for improving sustainability and competitive positioning. It is hoped that the findings identified and recommendations in this study will guide the leadership of HEIs in their GC implementation pursuits.

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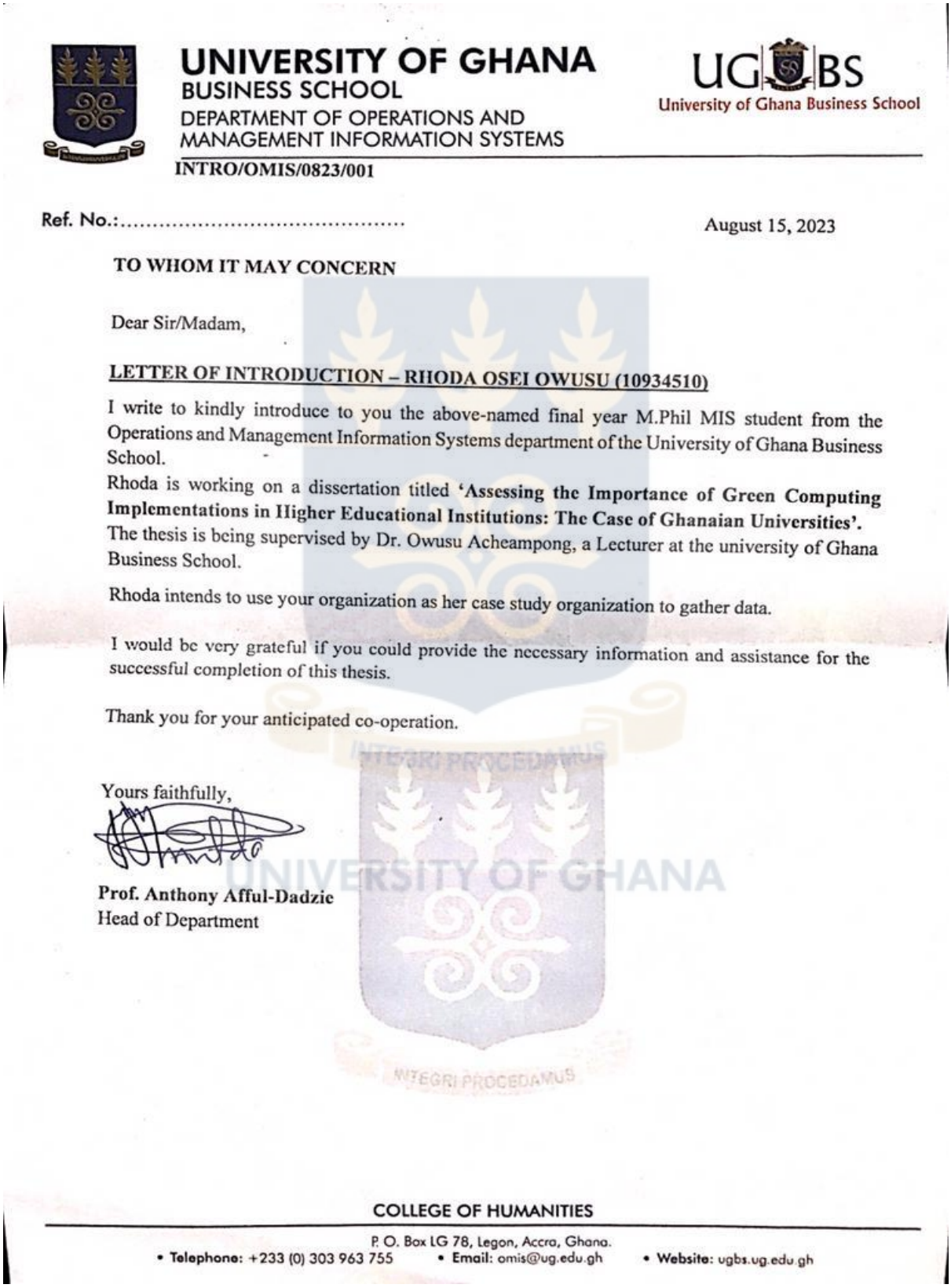
Appendix

A: Introductory letter



UNIVERSITY OF GHANA
BUSINESS SCHOOL
DEPARTMENT OF OPERATIONS AND MANAGEMENT INFORMATION SYSTEMS

UGBS
University of Ghana Business School

INTRO/OMIS/0823/001

Ref. No.:.....

August 15, 2023

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION – RHODA OSEI OWUSU (10934510)

I write to kindly introduce to you the above-named final year M.Phil MIS student from the Operations and Management Information Systems department of the University of Ghana Business School.

Rhoda is working on a dissertation titled **'Assessing the Importance of Green Computing Implementations in Higher Educational Institutions: The Case of Ghanaian Universities'.** The thesis is being supervised by Dr. Owusu Acheampong, a Lecturer at the university of Ghana Business School.

Rhoda intends to use your organization as her case study organization to gather data.

I would be very grateful if you could provide the necessary information and assistance for the successful completion of this thesis.

Thank you for your anticipated co-operation.

Yours faithfully,

Prof. Anthony Afful-Dadzie
Head of Department

COLLEGE OF HUMANITIES

P. O. Box LG 78, Legon, Accra, Ghana.
• Telephone: +233 (0) 303 963 755 • Email: omis@ug.edu.gh • Website: ugbs.ug.edu.gh

B: Questionnaire

Appendix B

Questionnaire

Department of Operations and Management Information Systems

INTRODUCTION

This questionnaire is targeted at Information Technology (I.T.) Professionals, Academicians and Top Managers in IT decision making at Institutions of Higher Learning in Ghana.

My name is Rhoda Osei Owusu, an MPhil Management Information Systems student from the University of Ghana Business School conducting a study on "**ASSESSING THE EFFECTIVENESS OF GREEN COMPUTING IMPLEMENTATIONS IN HIGHER EDUCATIONAL INSTITIONS: THE CASE OF GHANAIAN UNIVERSITIES"**. The study seeks to assess the implementation effectiveness of Green Computing in Ghanaian Universities and its impact on Universities sustainable competitive advantage.

Objectives of the study

1. To assess the current state of Green Computing implementation in Ghanaian Universities

2. To assess the implementation effectiveness of Green Computing in Ghanaian Universities
3. To assess the impact of Green Computing Implementation Effectiveness on Universities Sustainable Competitive Advantage
4. To assess the moderating effects of Organisational Culture and leadership style on Universities Sustainable Competitive Advantage

Your participation is voluntary, as you are not required to answer any question seen uncomfortable. Strict confidentiality is assured, as your responses to items on this questionnaire will not be subject to any public disclosure and will be used for academic purposes only. **This questionnaire will take approximately less than 20 minutes to complete should you decide to participate**.

Thank you in advance for taking the time to answer the questionnaire and for your valuable contribution. For any question, kindly contact me through email: rosei_owusu@st.ug.edu.gh or telephone number: 0544 346878 or my Supervisor, Dr. Acheampong Owusu (aowusu@ug.edu.gh)

SECTION A: DEMOGRAPHIC INFORMATION

Please tick [√] where appropriate

1. Gender: [ ] Male [ ] Female

2. Age: [ ] 21-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ] Above 60

3. Please indicate your highest completed level of education

[ ] Diploma [ ] First Degree [ ] Masters [ ] PhD [ ] Others (Specify)……

4. Which category of University in Ghana do you work with?

[ ] Private [ ] Public

5. Please indicate the name of the University in Ghana you work with?

Please specify …….

6. Please indicate your job title/current position in your respective university

[ ] IT staff [ ] Procurement staff [ ] ICT Manager [ ] Other Senior Manager [ ] ICT Director

[ ] Other Director [ ] IT/IS Faculty Member [ ] Other Faculty Member

7. How long have you been working in this University?

[ ] Less than 2years [ ] 2 to 5years years [ ] 6-10years [ ] 11-15 years [ ] Above 15 years

SECTION B: GREEN COMPUTING IMPLEMENTATIONS IN UNIVERSITIES

(THIS SECTION ENABLES THE RESEARCHER TO STUDY THE ADOPTION AND IMPLEMENTATION OF GREEN COMPUTING IN GHANAIAN UNIVERSITIES)

Please tick [√] as appropriate)

8. Are you familiar with the term "Green Computing"? (Green Computing refers to ensuring environmental sustainability in the life cycle of computing and digital technologies in-order to reduce power consumption and environmental impact, as well as developing strategies and tools to guide and promote enterprises' green practices)

[ ] Yes, [ ] No

9. Is Green computing important to your organisation? [ ] Yes, [ ] No.

10. Has your institution adopted and implemented any Green Computing initiative?

[ ] Yes, [ ] No

11. Which of the following Green Computing initiative has your institution adopted and implemented? (Tick as appropriate if you answered "Yes" for Question 10)

[ ] Energy-efficient appliances [ ] Thin client computers [ ] Green policy [ ] Green strategy [ ] Telecommuting [ ] Energy-Efficient Data Centers [ ] Sustainability Champions or

Administrators [ ] E-learning portals [ ] Efficient E-waste disposal [ ] E-waste recycling [ ] Cloud Computing [ ] Server Virtualization [ ] Centralized Power management [ ] Online Assessments [ ] Online Applications [ ] Green Procurement [ ] Green Awareness and Training [ ] Electronic Pay-slips [ ] Institutional Emails use [ ] Others, please specify…….....

12. Have the leadership team/top Management (e.g., the VC, Registrar, Directors) made an "explicit and Vigorous commitment to Green Computing initiatives" in your institution?

[ ] Yes, [ ] No.

SECTION C: UNIQUE RESOURCES AND CAPABILITIES THAT INFLUENCE EFFECTIVE GREEN COMPUTING IMPLEMENTATIONS IN GHANAIAN UNIVERSITIES

In this section, please indicate the extent to which you agree or disagree with the following statements regarding the unique resources and capabilities that influence the effectiveness of Green Computing implementations in HEIs. Tick the appropriate number on the Likert Scale of 1 to 5; where 1= Strongly Disagree (SD), 2= Disagree (D), 3= Neutral (N), 4= Agree (A), 5= Strongly Agree (SA).

No.	Statement	SD (1)	D(2)	N(3)	A(4)	SA(5)
Resources (Refer to commodity-like assets that are widely available and can be purchased from the factor market)						

1.	Resource identification, availability and associated costs are important for Green Computing implementations in our institution	1	2	3	4	5
2.	Physical and Technological infrastructure (including datacenters, energy-efficient hardware, software, and systems) enable our institution to implement sustainable computing practices	1	2	3	4	5
3.	Resources are readily available for Green Computing initiatives in our institution	1	2	3	4	5
4.	The top management of our institution is willing to allocate necessary resources for Green Computing initiatives	1	2	3	4	5
5.	Resources are constantly maintained to protect our institution's resources against ever-shifting market circumstances	1	2	3	4	5
Intangible Assets (Refer to any abstract thing an institution uses in its processes to create, produce, and/or offer its products (goods or services) to a market						
1.	Our institution values environmental sustainability	1	2	3	4	5
2.	Our institution has policies on Green Computing implementations (Green use, green disposal)	1	2	3	4	5

3.	Our institution has documented Green Computing implementation strategies	1	2	3	4	5
4.	Our institution confirms to industry standards when procuring computing and other electronic devices (E.g.: EPA's Energy star ratings,)	1	2	3	4	5
5.	Our institution has a good reputation for Green Computing initiatives and practices	1	2	3	4	5
Capability (Refers to skills, competencies, know-how to coordinate resources and use them in an effective way)						
1.	Our institution has the ability to identify the resources needed for Green computing implementation	1	2	3	4	5
2.	Our management has the capability to effectively coordinate and allocate internal competencies for the success of Green Computing implementations	1	2	3	4	5
3.	Our institution has designated Sustainability Champions/ Administrators to promote sustainability principles and awareness	1	2	3	4	5
4.	Our ICT personnel have the required knowledge and skills on Green Computing implementation	1	2	3	4	5

5.	Our ICT personnel are constantly trained to develop new capabilities to support Green Computing initiatives	1	2	3	4	5
6.	Top management has adequate understanding of the Green organisational culture dynamics in our organisation	1	2	3	4	5
7.	Our top management has the ability to align Green computing strategies to overall business strategy	1	2	3	4	5
Absorptive Capacity (Refers to a firm's ability to recognize the value of new information, assimilate, and apply it to improve its innovative performance)						
1.	Our institution makes conscious effort to analyze and recognize the potential of Green computing in enhancing Universities performance	1	2	3	4	5
2.	Our institution continuously examines innovative opportunities that Green Computing can provide	1	2	3	4	5
3.	Our institution has adequate knowledge of the dimensions and strategies of Green computing implementation	1	2	3	4	5
4.	Our institution understands and apply external knowledge to invent new Green Computing opportunities	1	2	3	4	5

5.	Our institution has the ability to combine existing with newly acquired knowledge to improve Green Computing initiatives	1	2	3	4	5
6.	Our institution promotes sustainability principles and awareness among the university community	1	2	3	4	5
Agility (Refers to the ability to respond quickly and flexibly to changes presented by the internal and external environment to maintain above average performance)						
1.	Our institution is able to anticipate changes (opportunities and threats) in the educational sector related to Green computing initiatives	1	2	3	4	5
2.	Our institution is proactive in responding to these changes	1	2	3	4	5
3.	Our institution is equipped to manage these changes	1	2	3	4	5
4.	Our institution constantly conduct market surveillance to identify current technologies to support green initiatives	1	2	3	4	5
5.	Our institution follows formal procedures (change management process) when implementing changes related to Green computing initiatives	1	2	3	4	5
6.	Our institution adapts to changing regulations, technology advancements, and	1	2	3	4	5

	stakeholder demands related to Green computing initiatives					
Environmental Turbulence (*Refers to the degree of change in technology, customer demand, and market competition intensity in an industry*)						
2.	External factors such as changes in government policies, market forces can affect our institution's green computing initiatives	1	2	3	4	5
2.	Disposing of computing and electrical equipment are regulated by industry policies	1	2	3	4	5
3.	Our institution is able to sense shifting boundaries in the educational sector	1	2	3	4	5
4.	Our institution has a good understanding of other competing Universities strengths and weaknesses	1	2	3	4	5
5.	Our institution is aware of new and emerging markets that could be reached using Green computing implementations	1	2	3	4	5

SECTION D: EFFECTIVE GREEN COMPUTING IMPLEMENTATIONS IN GHANAIAN UNIVERSITIES

In this section, please indicate the extent to which you agree or disagree with the following statements regarding the effectiveness of Green Computing implementations in HEIs. Tick the appropriate number on the Likert Scale of 1 to 5; where 1= Strongly Disagree (SD), 2= Disagree (D), 3= Neutral (N), 4= Agree (A), 5= Strongly Agree (SA).

Effective Green Computing Implementations (*Refers to the degree to which Green Computing Implementation is successful in producing a desired result)*						
No.	**Statement**	**SD (1)**	**D(2)**	**N(3)**	**A(4)**	**SA(5)**
1.	Green Computing Implementation has helped reduce our I.T. equipment energy consumption	1	2	3	4	5
2.	Green Computing Implementation has helped reduce our operational costs (E.g. The use of Energy Star-rated devices, Paperless admission applications, and E-learning)	1	2	3	4	5
3.	Green Computing initiatives have helped to reduce and recycle our electronic waste	1	2	3	4	5
4.	Green Computing Implementation has helped reduce our carbon footprints	1	2	3	4	5
5.	Green Computing Implementation has helped raise environmental sustainability awareness	1	2	3	4	5

SECTION E: MODERATING VARIABLES

In this section, please indicate the extent to which you agree or disagree with the following statements that moderates Green Computing implementation and Competitive Advantage. Tick the appropriate number on the Likert Scale of 1 to 5; where 1= Strongly Disagree (SD), 2= Disagree (D), 3= Neutral (N), 4= Agree (A), 5= Strongly Agree (SA).

Organisational Green Culture (*Refers to a collection of artefacts, assumptions, and values reflecting firms' activities to encourage environmental sustainability in their operations)*						
No.	**Statement**	**SD (1)**	**D(2)**	**N(3)**	**A(4)**	**SA(5)**
1.	Internal social and cultural norms affect our institution's green computing initiatives influencing its ability to be innovative and competitive	1	2	3	4	5
2.	Shared values influence the attitude toward our institutional green learning and practices	1	2	3	4	5
3.	Our institution has imbibed green initiatives in the values, beliefs, and behaviors of its stakeholders	1	2	3	4	5
4.	Our institution has aligned Green Computing implementation policies with its corporate strategies and policies	1	2	3	4	5
5.	Top management or sustainability administrators constantly create awareness about environmental sustainability in our institution	1	2	3	4	5
6.	Our institution practices a maintenance culture of the Green Computing infrastructure	1	2	3	4	5
Leadership Style (*Refers to the relatively consistent pattern of behaviour that characterizes and distinguishes a given leader)*						

No.	Statement	SD (1)	D(2)	N(3)	A(4)	SA(5)
1.	Our top managers use persuasive leadership to promote green behavior among employees	1	2	3	4	5
2.	Our top management motivates stakeholders to undertake green practices	1	2	3	4	5
3.	Our top management assigns clear responsibility and authority for Green Computing direction and initiatives	1	2	3	4	5
4.	Our top management enforces green policies and strategies	1	2	3	4	5
5.	Our top management promotes green computing awareness and practices	1	2	3	4	5
6.	Our top management rewards or reprimands for conformance and non-conformance to Green implementation policies and standards	1	2	3	4	5

SECTION F: UNIVERSITIES SUSTAINED COMPETITIVE ADVANTAGE

In this section, please indicate the extent to which you agree or disagree with the following statements regarding Green Computing and competitive advantage. Tick the appropriate number on the Likert Scale of 1 to 5; where 1= Strongly Disagree (SD), 2= Disagree (D), 3= Neutral (N), 4= Agree (A), 5= Strongly Agree (SA).

Sustained Competitive Advantage ***(Refers to long-term benefits of implementing business strategies that puts a firm in a superior position because of their unique products or services offerings)***						
No.	**Statement**	**SD (1)**	**D(2)**	**N(3)**	**A(4)**	**SA(5)**

1.	Green Computing initiatives support our University's core competencies enabling it to exploit market opportunities and neutralize competitive threats	1	2	3	4	5
2.	Green Computing implementation has enhanced our University's recognition and reputation (Green Metric World University ranking)	1	2	3	4	5
3.	Our student enrollment has increased as a result of Green Computing initiatives (E.g. E-learning, Telecommuting)	1	2	3	4	5
4.	Demand for our institution's online or blended-mode programmes has increased as a result of Green computing initiatives	1	2	3	4	5
5.	Our University has copyrights and intellectual property rights for Green Computing initiatives	1	2	3	4	5
6.	There are significant improvements in our University's annual revenues as a result of green computing initiatives	1	2	3	4	5
7.	It is difficult for other universities to identify and imitate the capabilities and resources we use for effective Green computing initiatives	1	2	3	4	5

Thank you for your participation!