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RESEARCH ARTICLE:

Drivers to Promote the Adoption of Green Information Communication Technology in South African SMEs

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Abstract

Despite the numerous benefits of green information and communication technology (GICT), the adoption rate among small and medium enterprises (SMEs) in South Africa remains low. Limited financial resources, lack of awareness, inadequate technical skills and insufficient government support hinder effective implementation and integration of GICT. The objective is to identify the most prominent drivers for enhancing the adoption of GICT after which recommendations can be made. By understanding these drivers, SMEs can be encouraged to adopt GICT practices to benefit from them. The identified drivers, drawn from existing literature, were incorporated into a measurement tool. Data was gathered through an electronic survey using a self-administered questionnaire. The respondents' perceptions regarding the drivers of GICT adoption were examined. An exploratory factor analysis revealed that the most prominent drivers for enhancing GICT adoption are eco-friendliness, environmental conditions, cost, and competitive advantage. It is recommended that SMEs adopt a proactive approach to integrating GICT initiatives into their business strategies. By fostering collaborations with other businesses, industry stakeholders, and policymakers, SMEs can lead the way in establishing robust environmental certification practices. The study concludes that these types of partnerships will not only enhance sustainability efforts but also position SMEs as leaders in the transition to greener, more efficient operations.

Keywords: *green information and communication technology; drivers; SMEs; eco-friendly consciousness; environmental conditions*

Introduction

The research reported in this paper pertains to the low rate of GICT adoption among SMEs especially in developing countries such as South Africa Green information communication technology (GICT) significantly contributes to environmental management by minimising the adverse effects of ICTs on the environment. Li, Zhu, Guan and Kang (2022: 734) state that GICT refers to information and communication technologies that seek to decrease the energy they use. In general, three layers of ICT demonstrate environmental factors that must be taken into consideration: a) the first level - the consequences of ICT hardware; b) second level is that ICT can alter processes; and c) the third level - impacts of the environment on the medium- or long-term adaptation of behaviour (Thabit, Aissa and Jasim, 2021: 10-11). Moreover, there is a dearth of research and documentation about GICT, which is a complicated topic that is evolving quickly. Therefore, Gotay (2020: 20) states that more research on GICT is needed especially to address the void of knowledge in this field. The green ''by ICT'' perspective represents the use of intelligent applications that can potentially lower carbon emissions across various sectors through monitoring while the green ''of ICT'' perspective signifies the reduction of the impact generated by this application (Popli, Jha and Jain, 2021: 3). This is in line with the notion of Gotay (2020: 2) that the terms "green IT" and "GICT" are synonymous and are used interchangeably. Ceci and Razzaq (2023: 4) emphasise that the impact of ICT on the

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environment has facilitated energy-efficient businesses throughout the lifecycle of IT hardware and network devices, from manufacturing and usage to disposal.

Environmental tax policies can promote the integration of eco-friendly energy sources and the adoption of more sustainable operational procedures by offering incentives for sustainable alternatives (Wang, Qamruzzaman and Kor, 2023: 19). Akinode and Oloruntoba (2020: 188) believe that artificial intelligence (AI) can aid in waste and materials sorting, facilitating their accurate separation and collection for potential reuse as AI is a major catalyst for the fourth industrial revolution (4IR). It may be concluded that AI integrated with 4IR technologies could enhance energy efficiency processes to enable the adoption of GICT by SMEs. In South Africa, SMEs are categorised as businesses that employ between 50 and 200 people, have an estimated annual turnover ranging from R10 million to R40 million, and possess gross assets valued between R3.75 million and R15 million, excluding property assets. (Akoh, 2024: 1) SMEs play a vital role in the economy of South Africa, contributing significantly to employment and economic growth. However, the effective utilisation of ICT by SMEs continues to be a major challenge in Sout Africa, where they encounter unique challenges such as limited access to resources, financial constraints and insufficient technical skills, which can hinder their ability to adopt new technologies like GICT (Mudzamba, van der Schyf and Renaud, 2022: 1-2). Understanding these conditions is crucial to exploring the factors that influence GICT adoption within this context.

There is an existing research gap in the literature regarding GICT adoption and the aim of this study is to propose business strategies that could offer guidance to SMEs seeking to implement GICT (Gotay, 2020: 20). While ICT has significantly benefited businesses, it can also lead to adverse outcomes due to gaps in knowledge about its adoption, misunderstandings surrounding its implementation, limited capacity to scale resources and misalignment with business objectives (Shahadat, Nekmahmud, Ebrahimi and Fekete-Farkas, 2023: 2). Moreover, addressing these gaps will assist SMEs to understand both direct and indirect impacts of GICT. In this study, a quantitative, non-experimental, and descriptive research design will be employed to investigate the low adoption rate of ICT among SMEs. By focusing on this design, the study aims to provide a detailed analysis of the factors influencing GICT adoption, without manipulating variables. This approach will allow for a clear understanding of the drivers that may encourage SMEs to adopt GICT, contributing valuable insights to the existing body of knowledge on the topic. This paper seeks to address the low GICT adoption rate through the primary objective to identify the most prominent drivers for enhancing the adoption of GICT after which recommendations can be made.

The research problem is the low rate of GICT adoption among SMEs especially in developing countries such as South Africa. Although the potential of GICT to support sustainable development, its adoption in developing countries, particularly in Africa, remains limited, with only a few countries like South Africa, Nigeria, Algeria, and Egypt making notable progress, while many others lag in adoption and infrastructure development Sekwatlakwatla and Malele, 2024: 1). However, progress remains limited and slow with GICT adoption among South African SMEs. With the rapid advancement of information and communication technology (ICT) more research is called upon (Mustonen, 2024). Further, GICT has been predominantly associated with developed nations, resulting in a notable gap in scholarly contributions from the developing world (Hussain, Gul and Ullah, 2023). Research on the adoption and impact of ICT in developing regions remains limited, further exacerbating this disparity. This study aims to address this gap by contributing to the growing body of knowledge on green information and communication technology (GICT) within the context of developing countries, with a specific focus on South Africa. By offering insights into the unique challenges and opportunities faced by these regions, this research seeks to enrich the academic discourse surrounding ICT development and implementation in South Africa and developing countries.

The high initial expenses of implementing GICT, the requirement for specialised knowledge and the complexity of calculating the environmental impact of GICT efforts are some of the challenges for the introduction of GICT (Purwaningsih, 2018: 20404; Popli *et al.,* 2021: 34; Ramli, Chew and Saptari, 2021: 1435). The focus of the paper through the primary objective is–to identify the most prominent drivers for enhancing the adoption of GICT to ultimately achieve sustainable business practices. With the fundamental drivers identified the benefits can then be promoted to increase GICT adoption. Moreover, the specific drivers enhancing the adoption rate of GICT in operational practices are examined due to a lack of information in the literature. It is therefore important to investigate the drivers that influence the adoption rate of GICT as South Africa is considered one of the largest CO_2 emitters worldwide (Global Carbon Atlas, 2023). The problem, therefore, is the low adoption rate of GICT in South African SMEs. SMEs might find it difficult to adopt GICT due to the absence of funding which can impede

its adoption (Chandavarkar and Nethravathi, 2023: 14). To address the problem, the objective is to identify the most prominent drivers for enhancing the adoption of GICT. SMEs can gain significant advantages by adopting GICT practices once they acknowledge the critical role these practices play in their business success (Chandavarkar and Nethravathi, 2023: 14). Without the identification of GICT drivers, organisations will not be able to reap the benefits of GICT.

Review of Literature

This section of the paper provides a concise review that outlines the background of GICT, an overall comprehension of the definition of GICT and a detailed presentation of the various drivers of GICT as identified from the literature.

Due to the unique nature of the GICT concept, this paper will use the following definition: GICT alludes to the practice of using computers and IT resources more responsibly and efficiently from an environmental perspective (Thabit *et al.,* 2021: 12). GICT infrastructure is essential for sustainable production and consumption, as well as climate change mitigation through cleaner manufacturing practices and environmental legislation that transform international policy toward long-term growth (Anser *et al.*, 2021: 21065). Implementing GICT practices may therefore necessitate the replacement of environmentally unfriendly business processes and the development of sustainable business practices. A synopsis of the main principles linked to GICT is provided in Table 1 below.

Table 1: Concepts and definitions related to GICT

Concept	Definition	Source
a) Eco-innovation (green innovation or sustainable innovation)	Innovation in favour of more environmentally responsible procedures that keep resource consumption and waste production within an appropriate parameter.	Kılkış (2016: 235)
	Innovations that promote a sustainable environment by generating ecological enhancements	Xavier, Naveiro, Aoussat and Reyes (2017: 1281)
b) ICT for sustainability	A discipline that offers a critical viewpoint that challenges every technological advancement by examining its effects on society.	Pattinson (2017: 12941)
c) Environmental technologies	Generally, it refers to new or modified procedures and goods that allow businesses to lessen adverse environmental effects compared to appropriate alternatives.	Ozusaglam, Kesidou and Wong (2018: 114)
d) Efficiency-increasing technologies	Refer to the introduction of new production techniques and/or their adaptation to current ones that use less energy or input (and thereby reduce pollution by optimising operational effectiveness)	Ozusaglam *et al.* (2018: 114)
e) Green computing	Refers to the use of information technology in a way that does the least possible amount of harm to the environment and society as a whole	Banerjee, Sing, Chowdhury and Anwar (2018: 90)

Source: *Authors' own compilation (2024)*

As can be observed, the literature does not provide a unified definition of GICT (Table 1). In light of the distinctiveness of the GICT term, the authors would like to summarise the following GICT definition derived from literature: *"the ability to utilise technology efficiently and effectively with very low or no environmental impact".* This section clarified essential ideas of GICT and identified a definition relevant to this research as study various terms are being used interchangeably in the literature. The benefits of GICT will be described in the following section.

Adopting GICT can benefit SMEs economically and environmentally. GICT may reduce numerous environmental impacts and increase the efficiency of several activities. It is anticipated that the adoption of GICT will eventually have a positive impact on the environment. GICT can minimise energy use, which can lessen greenhouse gas emissions and assist in combating climate change (Thabit *et al.,* 2021: 15). Literature outlines several benefits of GICT; environmental protection activities, cost and energy efficiency, cost savings, and the need for fewer resources. Gotay (2020: 8) states that adopting GICT offers several advantages for corporate leaders, including enhancing the firm's social image, complying with regulatory requirements, and improving the management of

energy resources and facilities. These are just some of the numerous benefits of GICT that have the potential to lead to more sustainable behaviours. Concurrently, these behaviours may, in turn, benefit both the environment and SMEs. Without capitalising on the benefits associated with the implementation of ICT initiatives, SMEs are missing out on the numerous benefits these technologies offer (Chandavarkar and Nethravathi, 2023: 14). It can therefore be concluded that SMEs should adopt GICT practices to achieve profitable benefits and transition towards a more sustainable environment. The next section provides an overview of the general drivers of GICT adoption identified from the literature.

A thorough literature analysis was conducted with the explicit goal of examining the circumstances surrounding the drivers that influence the adoption of GICT. The reasons for the adoption of GICT were determined from the literature, and the authors searched various sources from both developing and developed countries that show parallels to South Africa. The literature identifies four primary drivers for GICT as: cost reduction, competitive advantage, product life cycle management, and environmental conditions (Table 2). Cost Reduction: One of the key motivations for adopting GICT is the potential for cost savings, particularly using cloud computing applications. These applications reduce the need for expensive hardware, thereby enhancing ICT performance while minimizing environmental impact. Additionally, GICT improves operational efficiency, leading to lower maintenance costs and overall operational expenses. By adopting eco-friendly business practices, organisations can achieve significant cost reductions (Table 2).

Competitive Advantage: GICT also offers a competitive edge by enabling the production of green products, which appeal to environmentally conscious consumers. The integration of green technologies has become essential for maintaining a competitive advantage and ensuring long-term sustainability. Through GICT, companies can provide cost-effective goods and services that also minimise their environmental footprint (Table 2). Product Life Cycle Management: This driver focuses on optimising the use of physical resources and reducing waste through recycling. By utilising green products, up to 90% of hardware can be reprocessed, contributing to more sustainable practices. Life Cycle Assessment (LCA) is a crucial tool for evaluating the environmental impact of a product throughout its entire lifespan, from the extraction of natural resources to production, transportation, functionality, maintenance, and eventual reuse (Table 2). Environmental Conditions: Finally, environmental conditions, particularly adherence to standards like ISO 14001, play a significant role in driving GICT adoption. Environmental management systems not only enhance ecological performance but also boost profitability. Companies that implement GICT solutions contribute to the reduction of CO2 emissions, thereby helping to protect and restore the natural environment. Environmental factors such as pollution, resource depletion, and global warming underscore the importance of considering environmental impacts throughout the product lifecycle. GICT is increasingly recognised as a vital solution to these environmental challenges, particularly in emerging economies where rapid development has led to high CO2 emissions due to reliance on natural resources like coal (Table 2).

Table 2: Drivers influencing the adoption of GICT

Drivers (collective description)	Source	Country	Status (economy)
a) *Reduction in cost:* • Innovative GICT hardware and software can reduce costs, enhance performance, and minimise environmental impact. • Green technologies improve SMEs manufacturing efficiency and reduce operational expenses, such as maintenance. • Lower operational costs can be achieved through eco-friendly business practices, intelligent use of GICT in solutions,	Chou (2013: 233)	Global perspective	Developed and developing
	Masud and Malik (2014)	Malaysia	Developing
	ASSAf (2014: 145)	South Africa	Developing
	Akman and Mishra (2015: 477)	Turkey	Developing
	Hankel, Heimeriks and Lago (2017: 91)	Netherlands	Developed
	Corrocher and Solito (2017: 571)	European Union	Developed
	Marcon, de Medeiros and Ribeiro (2017: 88)	Brazil	Developing
	Banerjee *et al.* (2018: 96)	Global perspective	Developed and developing

Drivers (collective description)	Source	Country	Status (economy)
enhanced energy efficiency, and smarter material utilisation.	Radu (2016: 735-737)	Global perspective	Developed and developing
	Zhang and Liang (2012: 1004)	China	Developing
	Mele and Russo-Spena (2015: 13)	Italy	Developed
	Buchalcevova and Gala (2013: 46)	Czech Republic	Developed
	Buchalcevova and Gala (2012: 111)	Czech Republic	Developed
	Anthony and Majid (2016: 23)	Malaysia	Developing
	Wabwoba, Wanyembi, Omuterema and Mutua (2013: 94)	Kenya	Developing
b) *Competitive advantage:* • Facilitates market entry for businesses by producing green products, catering to the growing green-conscious customer base. • Green technologies are crucial for achieving competitiveness and are essential for the long-term sustainability of the business world. • Offers cost-effective pricing on goods and services while minimising environmental impact. Combines key skills and capabilities with enterprise training, modern infrastructure, incentives, and innovative technologies. Reduces energy costs and differentiates the business in the marketplace through GICT initiatives.	Chou (2013: 233)	Global perspective	Developed and developing
	ASSAf (2014: 143)	South Africa	Developing
	Akman and Mishra (2015: 484)	Turkey	Developing
	Cecere and Mazzanti (2017: 88)	European Union	Developed
	Aghelie (2017: 45)	Global perspective	Developed and developing
	Hamann, Smith, Tashman and Marshall (2017: 28)	South Africa	Developing
	Ozusaglam *et al.* (2018: 113-115)	European Union	Developed
	Banerjee *et al.* (2018: 90)	Global perspective	Developed and developing
	Radu (2016: 735-737)	Global perspective	Developed and developing
	Abdullah, Zailani, Iranmanesh and Jayaraman (2016: 691)	Malaysia	Developing
	Buchalcevova and Gala (2013: 46)	Czech Republic	Developed
	Anthony and Pa (2015: 43)	Malaysia	Developing
	Yang, Sun, Zhang and Wang (2017: 1377)	China	Developing
	Buchalcevova and Gala (2012: 111)	Czech Republic	Developed
c) *Product life cycle:* • Involves minimising the use of limited physical resources by employing green manufacturing processes such as recycling. For instance, 90% of technological devices like computers and cell phones can be reprocessed. Life cycle assessment is a technique used to evaluate the environmental	Hilty and Aebischer (2015: 23)	Global perspective	Developed and developing
	Andreopoulou (2016: 493)	European Union	Developed
	Klimova (2016: 116)	Global perspective	Developed and developing
	Marcon *et al.* (2017: 85)	Brazil	Developing
	Abdullah *et al.* (2016: 699-700)	Malaysia	Developing
	Anthony and Pa (2015: 41-42)	Malaysia	Developing
	Aleksic (2014)	Austria	Developed

Drivers (collective description)	Source	Country	Status (economy)
impact of products throughout their life cycle. • Green design considers the product, processes, and ecological impacts, such as recycling, from the design phase. It incorporates eco-friendly practices and technology in green lifecycle management. The complete life cycle of a product includes the extraction of natural resources, production, transportation, functionality, maintenance, and reuse phases. Life cycle assessment is a method used to assess the environmental impact of a product throughout its entire life cycle.	Buchalcevova and Gala (2012: 109-110)	Czech Republic	Developed
d) Environmental conditions: • The International Organisation for Standardization (ISO) 14001 enhances company performance. Environmental management systems can boost both the profitability and ecological performance of a business. Companies pursuing GICT (GICT) solutions reduce CO2 emissions, contributing to the protection and restoration of the natural environment. • Initial investments in environmental management can lead to improved returns on investment over time. • Environmental factors include pollution, depletion of finite resources, and global warming, highlighting the growing importance of considering environmental aspects throughout the entire product lifecycle. GICT is seen as a crucial solution to environmental challenges, as it reduces energy consumption. The rapid development of emerging economies has led to high levels of CO2 emissions, primarily due to reliance on natural resources such as coal.	Cuerva, Triguero-Cano and Córcoles (2014: 105-06)	Spain	Developed
	Muafi (2015: 723)	Indonesia	Developing
	Akman and Mishra (2015: 477)	Turkey	Developed
	Andreopoulou (2016: 494)	European Union	Developed
	Hojnik and Ruzzier (2017: 584)	European Union	Developed
	Corrocher and Solito (2017: 573)	European Union	Developed
	Aghelie (2017: 45)	Global perspective	Developed and developing
	Ozusaglam *et al.* (2018: 113)	European Union	Developed
	Radu (2016: 735, 740, 741)	Global perspective	Developed and developing
	Yang *et al.* (2017: 1371, 1377)	China	Developing
	Mele and Russo-Spena (2015: 10, 19-20)	Italy	Developed
	Buchalcevova and Gala (2013: 43)	Czech Republic	Developed
	Abdullah *et al.* (2016: 685)	Malaysia	Developing
	Chen and Chang (2013: 107)	Taiwan	Developing
	Zhang and Liu (2015: 12)	China	Developing
	Wabwoba *et al.* (2013: 94)	Kenya	Developing
	Lee (2017: 1123)	Korea	Developing

Source: *Authors*' compilation (2024)

These drivers to the adoption of GICT are classified in broad terms as: reduction in cost, competitive advantage, product life cycle and environmental conditions (Table 2). The research method is explored in greater depth in the following section.

Research Method

The objective is to identify the most prominent drivers for enhancing the adoption of GICT. The following section delves into more details regarding the research methodology. The study adhered to a positivist methodology, employing deductive reasoning and conducting a survey using a single methodological approach (Zou and Xu, 2023). It adopted a cross-sectional design, with a questionnaire and factor analysis utilised for data analysis (Figure 1). The research study's target population comprised all SMEs registered with The Innovation Hub. The unit of analysis focused on the collective perceptions of SME owners and managers registered with The Innovation Hub, specifically those involved in decision-making processes related to the adoption of GICT. A census study was conducted to ensure credible data that can inform decision-making effectively while minimising the risks associated with sampling errors (Bell, Bryman and Harley, 2019 188). This study employed a construct validity measurement to determine the key constructs being evaluated and to assess how accurately these constructs are represented by the test (Bell *et al.,* 2019: 46). Cronbach's alpha values were computed to assess the reliability of the scales used to measure the constructs under investigation. The researcher followed the University of South Africa (UNISA) research ethics policy to maintain a high standard of professional conduct throughout the study.

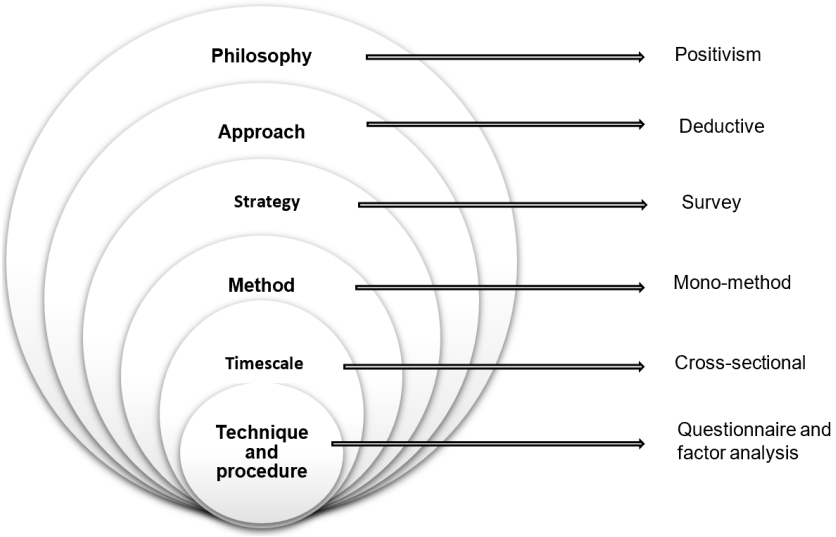

Figure 1: Outline of research philosophy and approach
Source: Adopted from Saunders, Lewis and Thornhill (2016: 124)

To investigate the factors contributing to the adoption rate of GICT in SMEs, a quantitative research method focusing on descriptive rather than experimental data was used. To fulfil the research objectives a thorough assessment of the literature, along with questionnaires and exploratory factor analysis (EFA) were followed to present the research findings. The determinants (Table 2) of GICT adoption were included in a self-administered questionnaire that was e-mailed to all potential participants (owners and managers) to collect data from SMEs. The study aims to encompass every SME affiliated with The Innovation Hub, totalling 400 registered SMEs during the research period, each having at least one designated contact person. The Innovation Hub, an innovation agency of Gauteng Province, operates as a fully owned subsidiary of the Gauteng Growth and Development Agency. It was founded by the Gauteng Provincial Government under its Department of Economic Development to enhance economic development and competitiveness in Gauteng by promoting innovation and entrepreneurship (The Innovation Hub, 2024). The Innovation Hub runs various programmes for enterprise development, skills enhancement, and fostering innovation. These initiatives include various incubation programmes such as green economy, smart industries and bioeconomy. The questionnaire that was used incorporated a 5-point Likert scale to rate the extent to which the participants agreed with the statements presented (Saunders *et al.,* 2016: 457).

The Likert scale comprised five points, where a rating of 1 indicated strong disagreement and 5 indicated strong agreement. The questionnaire was compiled based on the drivers identified in the literature (Table 2), with the origin of each item (from the literature) being indicated in Table 3 below.

Table 3: Questionnaire items

Item	Source
Increase the development of eco-friendly practices	Akman and Mishra (2015: 477)
Offer products with less impact on the environment	Verdolini, Bak, Ruet and Venkatachalam (2018: 3)
Reduce carbon emission	Zhang and Liu (2015: 12)
Contribute towards the reduction of waste	Anthony and Majid (2016: 1)
Increase the use of recyclables	Hilty and Aebischer (2015: 23)
Increase the reusability of products	Hilty and Aebischer (2015: 23)
Improve the competitiveness of environmental investments	Zhang and Liu (2015: 12)
Enhance the rebuilding of the natural environment.	Hojnik and Ruzzier (2017: 584)
Grow profit by environmental management systems	Hojnik and Ruzzier (2017: 584)
Decrease energy usage	Andreopoulou (2016: 493-494)
Enhance operational efficiency	Buchalcevova and Gala (2012: 111)
Decrease operational costs	Mele and Russo-Spena (2015: 13- 17)
Enhance innovative manufacturing processes	Akman and Mishra (2015: 477)
Allow the company to adjust easily to markets	Kanda, Sakao and Hjelm (2016: 164)
Distinguish the company from its competitors	Hamann *et al.* (2017: 30); Chou (2013: 233)

Source: Authors' compilation (2024)

Four constructs were initially identified in the literature: environmental conditions, reduction in cost, competitive advantage and product life cycle. However, the extracted eigenvalues revealed four components that included eco-friendly consciousness as well as environmental conditions, reduction in cost and competitive advantage. The eco-friendly consciousness component consists of items related to all four of the original constructs from the literature which proves these constructs are interrelated. Within this framework, eco-friendly consciousness has gained prominence for its hybrid role in improving environmental performance. Descriptive statistics were applied to collect, code and present the data rapidly simply and understandably (Leavy, 2017: 111–112). Multivariate statistical techniques (both univariate and bivariate analysis) were also used to examine several measurements of variables under investigation simultaneously; these included a factor analysis (Hair, Black, Babin and Anderson, 2019: 21–23). The data collected from the online and paper questionnaires was transferred to a Microsoft Excel spreadsheet, after which the data was coded electronically and analysed using IBM SPSS (Sekaran and Bougie, 2016: 328). The analytical methods, including descriptive, multivariate, and statistical measures used to analyse the data, involved the following EFA steps:

i. Bartlett's test of sphericity, which should be significant ($p < 0.05$) for factor analysis to be appropriate (Pallant, 2016: 183)
ii. The Kaizer-Meyer-Oklin (KMO), which measures a sampling adequacy yield greater than 0.6 and is acceptable for factor analysis (Pallant, 2016: 183)
iii. Cattell's scree test to plot the eigenvalues and identify a maximum number of factors extracted before the curve starts to straighten (Pallant, 2016: 184)
iv. Rotated factor analysis, which indicates the extent of correlation between each variable and each factor (Hair *et al.,* 2019: 172)
v. Cronbach's Alpha, the most used measure of reliability, reflects the average correlation among all items within the scale, with an acceptable threshold indicated by a value above 0.7 (Hair *et al.,* 2019: 775-776)

A census was considered suitable for sampling because of the limited size of the population. The sample size utilised for the study surpasses the conventional threshold of 50, which is typically deemed necessary for statistical significance and exceeds the minimum requirement for EFA (Hair *et al.,* 2019: 32–133). The researcher exerted diligent efforts to gather responses from every SME registered with The Innovation Hub. The following section offers further details regarding the results of the research study related to GICT in South African SMEs.

Results

The research results are reported in this section. The demographic information of the respondents is presented first followed by the statistical analysis. The surveys were sent to approximately 400 SMEs listed in The Innovation Hub's database, with one contact per enterprise. Out of these, 100 respondents completed the questionnaire, yielding a usable response rate of 25% for statistical data analysis.

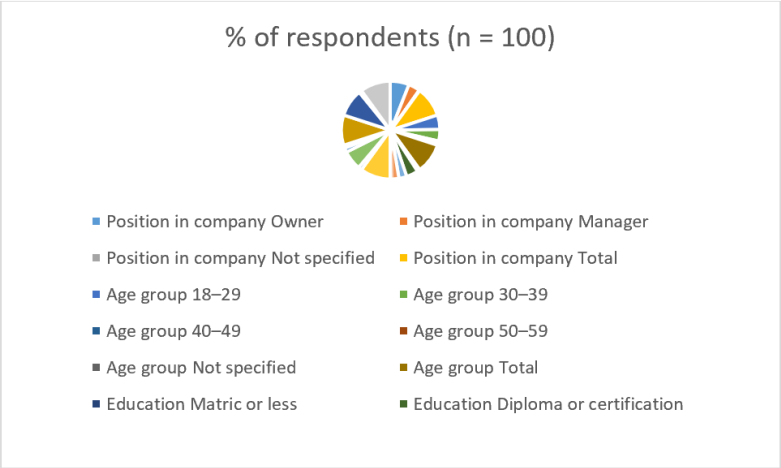

Figure 2: Respondent demographic information

Figure 2 depicts that the respondents in this study were owners of SMEs (60%) and managers (38%). Results indicate that two of the targeted respondents failed to mention their role in the company. The percentage of respondents holding higher education credentials is 90%, the percentage of respondents having between 1 to 5 years of working experience is 64% while the percentage of having work experience for 6 or more years is 14%. The percentage of businesses employing less than 50 individuals is 91% and the age group of employees ranging from 18 to 39 years is 86%. This indicates that most of the businesses were small in scale and therefore categorised as small and medium-sized enterprises.

In the validity assessment, items concerning the factors influencing the adoption of GICT were identified (Table 3). Subsequently, an EFA was conducted to investigate the data, aiding the researcher in interpreting and measuring the factor loadings based on the statistical outcomes (Sekaran and Bougie 2016: 222). Bartlett's test of sphericity, which assesses the suitability of factor analysis, showed significant results ($p < 0.05$) with a chi-square value of $X^2 = 817.04$ ($df=190$, $p=0.000$). These findings affirm that the data's correlations are sufficiently significant for conducting factor analysis (Pallant, 2016: 217). The KMO measure of sampling adequacy produced a value of 0.842, exceeding the threshold of 0.6, indicating adequacy for factor analysis. Table 4 demonstrates that both the KMO measure and Bartlett's test were statistically significant ($p < 0.05$), confirming the validity of the factor analysis. (Pallant 2016: 183). Thus, the chi-square approximation is significant regarding the factors influencing the adoption of GICT.

Table 4: KMO and Bartlett's test

KMO measure of sampling adequacy		0.842
Bartlett's test of sphericity	Approx. Chi-Square	817.042
	Df	190
	Sig	0.000

**Df = Degree of freedom*
***Sig = Significance*

Following the aforementioned, a Cattell's scree test was employed to plot eigenvalues and determine the maximum number of factors with eigenvalues exceeding 1.0 before the curve begins to flatten (Hair *et al.,* 2019: 124). The eigenvalues of the extracted components revealed only four values above 1 (4.47, 1.46, 1.12, 0.62), contributing

to a cumulative variance of 63.50%. Figure 3 displays a scree plot illustrating the variance among the extracted components.

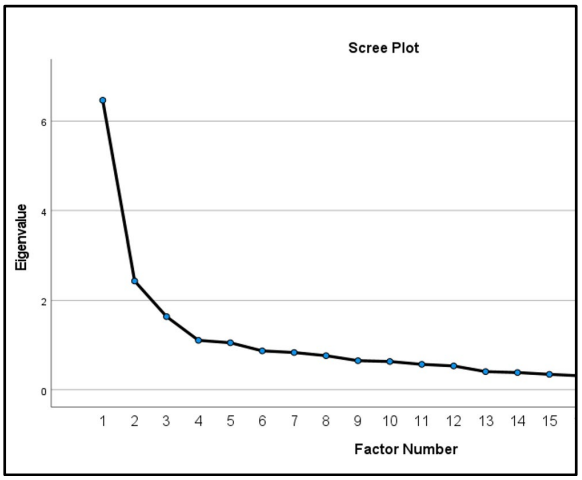

Figure 3: Scree test

In Figure 3 a significant difference is shown between components 1 and 2 compared to the other components. The plot indicates a distinct separation between components 3 and 4, which warrants further investigation. Overall, four factors were selected based on Cattell's scree test for further analysis and validation. Items were retained if their loadings were >0.60, and these items are closely associated with the identified factors and categorized according to communalities derived from shared variance measurements (Hair *et al.,* 2019: 633). High communalities are indicated as items correlate and load significantly on factors. In Table 5 the items loaded for each construct are reported.

Table 5: Rotated factor matrix

Construct	Items	Factor loadings			
		1	2	3	4
Eco-friendly consciousness	Increase the development of eco-friendly practices	**0.772**			
	Offer products with less impact on the environment	**0.737**			
	Reduce carbon emissions	**0.628**			
	Contribute towards the reduction of waste	**0.624**			
	Increase the use of recyclables	**0.621**			
	Increase the reusability of products	**0.536**			
Environmental conditions	Improve the competitiveness of environmental investments		**0.826**		
	Enhance the rebuilding of the natural environment		**0.659**		
	Grow profit by environmental management systems		**0.167**		
	Decrease energy usage		**0.542**		
Cost	Enhance operational efficiency			**0.771**	
	Decrease operational costs			**0.671**	
	Enhance innovative manufacturing processes			**0.308**	
Competitive advantage	Allow the company to adjust easily to markets				**0.751**
	Distinguish the company from its competitors				**0.619**
Cumulative percentage variance explained		**29.79**	**39.53**	**46.99**	**51.47**

Four constructs were originally discussed in the literature and the overall eigenvalues extracted four factors that were grouped into 15 items according to each factor. The cumulative percentage variance explained for the four factors amounted to 51.47%. The items extracted were represented by the following four factors (Table 5):

i. Eco-friendly consciousness (increase eco-friendly practices, eco-friendly products, diminish carbon emission, reduce waste, use of recyclables, reusability of products).
ii. Environmental conditions (improve environmental competitiveness, rebuild natural environment, profit through environmental systems, reduce energy use).
iii. Cost (increase operational efficiency, decrease operational cost, improve innovative manufacturing).
iv. Competitive advantage (company easily adjusts to markets, distinguishes SMEs from competitors).

In the next section, the findings and contributions of this study and possible recommendations for policymakers and SMEs regarding the adoption of GICT will be discussed.

Discussion of Findings

To address the problem, the primary objective is to identify the most prominent drivers for enhancing the adoption of GICT. The secondary objective was to provide recommendations to enhance the adoption of GICT in South African SMEs. It seems from the findings that the most prominent drivers for the adoption of GICT are an eco-friendly consciousness, environmental conditions, reduction in cost and competitive advantage. An eco-friendly consciousness leads to businesses being open to alternative sources or equipment with low power consumption, reducing dependence on non-renewable resources and traditional methods that lead to environmental degradation (Ceci and Razzaq, 2023: 3) Study findings indicate that the adoption and extensive use of eco-friendly technology can produce positive environmental outcomes by decreasing energy consumption and fostering sustainable practices (Wang *et al.,* 2023: 19). It is paramount for SMEs to explore various avenues in which they can reduce energy consumption and CO2 emissions. Andreopoulou (2016: 493), Klimova (2016: 116), Marcon *et al.* (2017: 85), and other scholars from both developed and developing countries (as referenced in Table 2) support the concept of eco-friendly consciousness. One widely recognized approach in this regard is life cycle assessment (LCA), a methodology used to evaluate the environmental impact of a product throughout its entire life cycle.

Environmental conditions pertain to businesses actively engaging in environmental activities that minimize negative impacts on the environment (Muafi, 2015: 723). This in return can result in a competitive advantage for the business (Hojnik and Ruzzier, 2017: 584). SMEs that comply with green environmental conditions are viewed in a positive light within the market (Chandavarkar and Nethravathi, 2023: 14). Further, authors such as Lee (2017: 1123), Yang *et al.,* (2017: 1371), and Ozusaglam *et al.* (2018: 113), along with others listed in Table 2, from both developed and developing countries, support this finding regarding the importance of environmental conditions. In summary, they emphasize that environmental factors, including pollution, depletion of finite resources, and global warming, are increasingly critical considerations. Therefore, this finding aligns with existing literature. Reduction in cost due to GICT practices can have a positive impact on profitability and is therefore a significant driver for SMEs. Just one example of a GICT cost reduction example is cloud computing which can reduce monthly data centre costs by up to 53% (Ardito and Morisio, 2014: 25). As SMEs aim to grow their businesses to become larger entities, this driver proves to be beneficial and should therefore be embraced. Hankel *et al.,* 2017: 91), Corrocher and Solito (2017: 571), Marcon *et al.,* 2017: 88), Banerjee *et al.* (2018: 96), along with other authors listed in Table 2, emphasize the significance of cost reduction through GICT. The references presented in Table 2 further reinforce the critical role of cost reduction through GICT in both developed and developing countries. Manufacturing practices can be adopted to require more green results which can ultimately lead towards a more favourable market position (Chandavarkar and Nethravathi, 2023: 14). SMEs should therefore aim to evaluate the introduction of GICT through a planned strategy to reap the benefits of competitive advantage. Ozusaglam et al. (2018: 113-115), Banerjee *et al.* (2018: 90), and other scholars from both developed and developing countries support the notion that GICT contributes to a competitive advantage. Therefore, this finding aligns with existing literature.

Building on the results of the initial objective, the following theoretical suggestions, if implemented by SMEs, could enhance the adoption of sustainable GICT practices (for each of the drivers):

i. Eco-friendly consciousness – provides products with minimal environmental impact and promotes greater use of recyclable materials as well as encourages product reusability.

ii. Environmental conditions – increase profitability through environmental management systems and reduce energy consumption.
iii. Cost reduction – reduce operational expenses and enhance innovative manufacturing techniques.
iv. Competitive advantage – enables the company to adapt quickly to market changes and differentiate itself from its competitors.
v. Finally, SMEs are further advised to evaluate and monitor the environmental impact of their GICT projects, using this information to improve their strategies and operational procedures. It is important to keep track of the progress made over time.

Further, recommendations are made to the managers of SMEs. Firstly, managers of SMEs could develop a well-defined corporate strategy for the implementation of GICT and allocate sufficient resources and funding to ensure successful execution. These strategies may include initiatives such as training employees in cloud computing applications. A critical step for SMEs is to enhance both employee and stakeholder understanding of GICT, which can be achieved through structured training programmes, workshops, and public awareness campaigns. As such, employee training is essential and should be integral to SME strategies. Furthermore, managers of SMEs might integrate sustainable practices by utilizing energy-efficient data centres, green computing systems, recycling initiatives, and programmes like Energy Star to promote investment in new, eco-friendly technologies (Kiruthika and Parimala, 2017; Gotay, 2020). SME managers also are encouraged to utilize ICT resources more responsibly, aligning their practices with environmental sustainability (Thabit *et al.,* 2021). This approach can yield multiple benefits, including cost reduction, improved corporate social image, compliance with regulatory requirements, and enhanced energy resource management (Gotay, 2020). Additionally, by leveraging the advantages of ICT initiatives, SMEs can unlock significant benefits, which many are currently overlooking (Chandavarkar and Nethravathi, 2023).

For policymakers, they are encouraged to introduce financial incentives, such as tax refunds or grants, to promote the adoption of GICT among companies, particularly SMEs (Gotay, 2020: 19). Offering financial benefits for GICT compliance would motivate SME managers to prioritize sustainability initiatives. These incentives could serve as a powerful mechanism to drive the implementation of GICT practices, enabling SMEs to align their operations with environmental sustainability goals. By reducing the financial burden associated with GICT adoption, such policies would foster a more widespread commitment to sustainable practices within the business sector. Policymakers can further support GICT initiatives, like cloud computing, by providing necessary infrastructure resources, which can lead to cost savings for SME owners through economies of scale. Moreover, policymakers can encourage SMEs to participate in corporate social responsibility (CSR) initiatives, especially relating to the environment. These CSR initiatives might also be rewarded with tax breaks or incentives (Gotay, 2020: 15). It is further the opinion of Gotay (2020: 15) that policymakers should avoid mandating non-compliance of GICT by applying penalties and should rather focus on positive rewards (Hassan, Yang, Usman, Bilal and Ullah, 2023: 18; Wang *et al.,* 2023: 20). With a holistic approach, SMEs can be encouraged to collaborate with policymakers and stakeholders to establish guidelines and policies promoting GICT adoption. These initiatives can be promoted through technology hubs and incubators that are financed by the government.

Conclusion

In conclusion, the findings suggest that the most prominent drivers for the adoption of GICT include eco-friendly consciousness, environmental conditions, cost reduction, and competitive advantage. Therefore, organisations are encouraged to implement GICT practices that enhance their market position and provide a competitive edge, ultimately contributing to a more sustainable future. In the presence of limited literature on GICT, this research makes a substantial contribution to managerial implications by proposing potential strategies to help SMEs and policymakers increase their level of GICT adoption. The study also makes a meaningful theoretical contribution by introducing a validated research tool and by testing the most prominent GICT drivers. The study's limitations include the exclusive focus on high-technology-based SMEs for data collection, which may not fully represent the perspectives of all organisations, particularly larger corporations. Further, the researchers faced budget and time constraints, impacting their study, yet these challenges also opened avenues for future research. They focused exclusively on SMEs registered with The Innovation Hub in Gauteng province, South Africa. Consequently, while the findings may not be universally applicable, they are considered sufficiently representative of similar economies in a South African context. Additionally, the sample was drawn from a single region, potentially limiting the

generalisability of the findings both within the country and internationally. A more diverse and inclusive research population could provide deeper insights into the perspectives of the broader business community. Future research could investigate the environmental management impact of GICT to develop a more comprehensive case study that supports green initiatives across both developed and developing countries. This would allow for a broader validation of the findings and contribute to a more robust understanding of GICT's role in sustainable business practices. Therefore, future research should consider a broader audience, including both SMEs and larger organisations, to examine the most influential GICT drivers for achieving sustainability. Additionally, expanding the study to both developed and developing countries could provide deeper insights into potential agreements or discrepancies regarding GICT drivers across different economic contexts.

Declarations

Interdisciplinary Scope: This study adopts an interdisciplinary scope by integrating insights from environmental science, information and communication technology, business management and policy studies to explore and enhance the adoption of green ICT practices among South African SMEs.

Author Contributions: Conceptualisation (Bok), literature review (Bok), methodology and analysis (Bok and Tolmay), drafting and preparation (Bok), review and editing (Bok and Tolmay). Both authors have read and approved the final version of the manuscript.

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