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Effect of Green Information and Communication Technology on Survival of Electricity Distribution Companies in Nigeria

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Abstract: *This study investigates the impact of Green Information and Communication Technology (Green ICT) on the survival of electricity distribution companies in Nigeria, emphasizing the critical dimensions of energy efficiency and renewable energy integration. Using a cross-sectional survey design, data was collected from key stakeholders in the electricity distribution sector and analyzed through multiple regression methods. The results indicate a significant positive correlation ($R = 0.713$) between Green ICT adoption and company survival, with energy efficiency and energy integration jointly explaining 50.8% ($R^2 = 0.508$) of the variation in survival rates. The ANOVA results further confirm the model's significance ($F = 12.743$, $p < 0.001$), demonstrating that Green ICT adoption substantially influences the sustainability of electricity distribution companies. The regression coefficients reveal that energy efficiency ($B = 0.234$, $p = 0.043$) and energy integration ($B = 0.287$, $p = 0.002$) both contribute positively to operational resilience, with energy integration exhibiting a stronger impact. These findings underscore the transformative potential of Green ICT in mitigating Nigeria's electricity sector challenges, including revenue shortfalls, operational inefficiencies, and environmental concerns. The study recommends that policymakers and industry leaders prioritize energy-efficient technologies, such as smart meters and optimized grid management systems, and invest in renewable energy sources to enhance sustainability. Such initiatives will not only ensure the long-term survival of electricity distribution companies but also align with global sustainability targets, positioning Nigeria's energy sector for a more resilient and environmentally responsible future.*

Keywords: *Green Information and Communication Technology (Green ICT), Energy Efficiency, Renewable Energy Integration, Sustainable Energy Practices and Survival*

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1.0 Introduction

The Nigerian electricity distribution sector faces significant challenges, including operational inefficiencies, revenue shortfalls, and environmental concerns. High energy losses, outdated infrastructure, and unsustainable energy consumption patterns have hampered the sector's ability to provide

reliable electricity. Green Information and Communication Technology (Green ICT) has emerged as a potential solution to these issues, promoting energy efficiency, cost reduction, and environmental sustainability.

Islam (2025) posits that Green ICT, encompassing sustainable technologies, practices, and strategies, offers a promising solution to these intertwined challenges. Through innovations such as smart grids, energy-efficient data centers, and automated demand-response systems, Green ICT can enhance electricity distribution efficiency. Despite these benefits, empirical research examining its impact on the Nigerian electricity sector remains limited (Omoyajowo, 2024). Addressing this gap is critical for understanding how Green ICT adoption can drive sustainability and operational resilience within the industry.

This study is anchored in the Diffusion of Innovation Theory, which explains how technological advancements are adopted and integrated within industries. The theory provides a framework for understanding the factors influencing Green ICT adoption and its subsequent impact on electricity distribution companies. By leveraging this theoretical perspective, the study explores the drivers, barriers, and strategic implications of Green ICT implementation in the Nigerian electricity distribution sector.

To achieve this, the study addresses the following research questions:

(i) What is the relationship between Green ICT adoption and the operational efficiency of electricity distribution companies in Nigeria?

(ii) How does Green ICT influence cost reduction and revenue generation in electricity distribution?

(iii) What are the key challenges and enablers of Green ICT adoption in Nigeria's electricity distribution sector?

This study argues that the adoption of Green ICT significantly enhances the operational efficiency, sustainability, and long-term survival of electricity distribution companies in Nigeria, making it a critical strategy for addressing energy sector challenges. By providing empirical evidence on the impact of Green ICT, the findings will inform policymakers, industry stakeholders, and researchers on best practices for integrating sustainable technologies within the electricity distribution sector.

1.1 Theoretical Foundation

1.1.1 The Diffusion of Innovation Theory

The Diffusion of Innovation Theory, developed by Everett Rogers in 1962, (Rogers, *et al.* 2014) serves as a critical underpinning for the study of Green Information and Communication Technology (Green ICT) and its impact on the survival of electricity distribution companies. This theory provides a structured framework for understanding how innovations, such as Green ICT, are adopted and disseminated within organizations and how these innovations can influence the long-term survival and sustainability of the companies involved. The theory categorizes adopters into distinct groups, ranging from innovators who embrace new technologies early to laggards who are slow to adopt. In the context of Green ICT, this categorization enables researchers to assess where electricity distribution companies stand on the adoption curve (Qin, *et al.*, 2022). Understanding the distribution of adopter categories within the sector allows for an analysis of the readiness and pace of Green ICT integration. Early adopters may experience competitive advantages and improved chances of survival, while laggards may face increasing challenges in a rapidly changing industry.

The theory helps identify the determinants influencing the adoption of Green ICT within electricity distribution companies. These determinants encompass factors such as the perceived advantages of Green ICT, its compatibility with existing practices, complexity, and observability. Researchers can investigate how these factors impact the

adoption decisions of companies and how they relate to the survival prospects of these organizations (Sinha & Noble, 2008; Thong & Yap, 1995;). A better understanding of these determinants can inform strategies for promoting the wider adoption of eco-friendly technology within the sector. The theory allows researchers to anticipate the consequences and outcomes of Green ICT adoption on the survival of electricity distribution companies. By examining how innovations diffuse and reshape organizations, researchers can assess the potential benefits, challenges, and long-term impacts of integrating Green ICT. Uddin and Rahman (2012) observed that, it includes evaluating how Green ICT affects operational efficiency, cost reduction, environmental sustainability, and overall competitiveness within the sector. The insights gained from applying the Diffusion of Innovation Theory can aid in making informed predictions about how Green ICT adoption may contribute to the survival and resilience of these critical utilities in the face of evolving industry dynamics and sustainability imperatives.

1.2 Conceptualization

1.2.1 Concept of Firm Survival

The concept of firm survival is a fundamental aspect of business management and strategy that refers to an organization's ability to maintain its existence and continue its operations over an extended period (Hillmann & Guenther, 2021). Survival is a core objective for businesses, as it underpins their capacity to achieve other goals, including profitability, growth, and long-term sustainability. Elali (2021) stated that one key aspect of firm survival is adaptability. In today's rapidly changing business environment, firms must be able to adapt to various challenges and uncertainties. This includes adjusting to shifts in market conditions, technological advancements, changes in consumer preferences, and competitive pressures. Karman (2020) suggested firms that are flexible and responsive to change are better positioned to survive and thrive over the long term. Adaptability often involves a willingness to innovate, restructure, and evolve in response to evolving circumstances (Olowu et al., 2024). Another critical element is financial viability. Firms must manage their financial resources effectively to ensure their survival (Wang, *et al*., 2020). This includes prudent financial planning, responsible debt management, and maintaining adequate cash reserves to weather economic downturns or unexpected crises. Businesses with strong financial foundations are more resilient and have a higher likelihood of surviving challenging periods (Adako et al., 2024). Competitive positioning also plays a crucial role in firm survival. In a competitive marketplace, firms must differentiate themselves from rivals, build brand loyalty, and continually create value for customers and stakeholders (Sudirjo, 2023). Maintaining a strong market presence and customer base enhances a firm's chances of long-term survival. This often involves a combination of offering high-quality products or services, delivering excellent customer experiences, and adapting to changing market dynamics.

1.2.2 Concept of Green Information and Communication Technology

The concept of Green Information and Communication Technology (Green ICT) represents a critical response to the environmental challenges posed by the rapid growth and widespread use of information and communication technologies (Nguyen, *et al* 2020). Green ICT, at its core, is a comprehensive approach that seeks to harness the power of information and communication technology while minimizing its environmental impact and promoting sustainability. One of the central tenets of Green ICT is energy efficiency. Sikder, Ahmed and Islam (2023) emphasize the development and utilization of energy-efficient hardware and software in the ICT sector. This involves designing more power-efficient processors, using low-energy components, and optimizing software to reduce

energy consumption (Adeusi et al., 2024). By doing so, Green ICT aims to mitigate the substantial energy demand of data centers, servers, and network infrastructure, which are critical components of our digital world (Orikpete , *et al.* 2023). Reducing energy consumption not only lowers operational costs but also contributes to a significant reduction in greenhouse gas emissions, aligning technology with environmental sustainability goals.

Another critical dimension of Green ICT is renewable energy integration. This entails the use of clean, sustainable energy sources, such as solar, wind, and hydropower, to power ICT infrastructure. Murshed (2020) observed that the shifting away from fossil fuels and adopting renewable energy, Green ICT reduces the carbon footprint associated with information technology. This not only lowers the environmental impact but also enhances the resilience of ICT systems by reducing vulnerability to power outages and energy price fluctuations. Furthermore, Green ICT encompasses responsible product lifecycle management. It promotes the design of electronic devices and components that are easier to recycle and that use fewer resources during manufacturing and transportation (Liu, *et al.,* 2023). It also emphasizes proper disposal and recycling practices to minimize electronic waste (e-waste), which can be hazardous to the environment. Adopting a lifecycle approach ensures that the environmental impact of ICT is reduced at all stages of a product's life, from production to disposal.

1.3 Dimensions of Green ICT

1.3.1 Energy Efficiency

Hao *et al.,* (2022) defined energy efficiency as a fundamental dimension of Green Information and Communication Technology (Green ICT) that emphasizes the responsible and efficient use of energy resources within the realm of information technology. In the era of rapidly advancing digital technology, the energy demand for data centers, electronic devices, and network infrastructure has surged, contributing significantly to environmental concerns and energy consumption. Energy Efficiency within Green ICT seeks to address these challenges by minimizing the energy consumption associated with ICT systems and operations (Bibri & Krogstie, 2020).

Central to the concept of Energy Efficiency is the development of energy-efficient hardware and software. This entails the design and manufacturing of electronic components and devices that consume less power during operation (Liang *et al,.* 2021). For instance, processors and data storage devices can be engineered to perform tasks with reduced energy consumption, and software applications can be optimized to run efficiently. Additionally, advanced cooling techniques, such as liquid cooling and free cooling, can be implemented in data centers to manage temperature without excessive energy use (Katal, Dahiya & Choudhury, 2023). Overall, Energy Efficiency encompasses a holistic approach to reducing energy waste within ICT systems, thereby lowering operational costs and reducing the carbon footprint associated with digital technology.

Energy Efficiency also plays a crucial role in promoting sustainability by aligning technology with environmental responsibility (Joel & Oguanobi, 2024). As the demand for digital services continues to grow, the efficient use of energy becomes paramount in mitigating climate change and reducing greenhouse gas emissions. Wehner, *et al.* (2022) said organizations that prioritize Energy Efficiency in their ICT operations not only contribute to a greener and more sustainable future but also benefit from cost savings and enhanced environmental stewardship. In essence, Energy Efficiency serves as a critical dimension of Green ICT, underscoring the importance of responsible energy consumption in the digital age.

1.3.2 Renewable Energy Integration

Renewable Energy Integration stands as a pivotal dimension within the realm of Green

Information and Communication Technology (Green ICT), representing the incorporation of clean, sustainable energy sources into the power supply of information and communication technology infrastructure (Agboola & Tunay, 2023). This concept acknowledges the critical role of energy sources in ICT operations and seeks to reduce the environmental impact of technology by shifting away from traditional, fossil-fuel-based energy generation. At its core, Renewable Energy Integration emphasizes the use of energy sources such as solar, wind, hydropower, and geothermal energy to power data centers, servers, networks, and electronic devices. Olujobi *et al*. (2020) said by replacing or supplementing conventional energy sources with renewable alternatives, organizations reduce their carbon footprint and contribute to mitigating climate change. This transition to renewable energy is not only environmentally responsible but also aligns with long-term sustainability goals.

The integration of renewable energy sources within Green ICT infrastructure enhances the resilience and reliability of technology operations (Ige, Kupa & Ilori, 2024). Unlike fossil fuels, renewable energy sources are not subject to the same price volatility or geopolitical risks, making them a more stable and sustainable choice. Moreover, renewable energy systems often incorporate energy storage solutions, such as batteries, which can provide backup power during outages, enhancing the continuity of ICT services. Liu & Liang (2024) opined renewable Energy Integration within Green ICT is a dynamic and forward-looking approach that acknowledges the critical link between energy generation and environmental sustainability. By harnessing clean energy sources, organizations not only reduce their carbon emissions but also position themselves as responsible stewards of the environment and champions of sustainability. This dimension underscores the transformative power of renewable energy in shaping a greener and more eco-conscious information technology landscape.

1.3.3 Relationship between Green Information and Communication Technology and Survival of Electricity Distribution Companies in Nigeria

The relationship between Green Information and Communication Technology (Green ICT) and the survival of electricity distribution companies in Nigeria is a multifaceted and increasingly vital connection. In a rapidly evolving energy landscape, the integration of Green ICT practices can have significant implications for the resilience, efficiency, and sustainability of electricity distribution companies (Agboola, *et al.*, 2023). The adoption of Green ICT initiatives can contribute to the operational efficiency of electricity distribution companies. Implementing energy-efficient hardware, optimizing software, and adopting smart grid technologies can reduce energy losses during electricity distribution, leading to cost savings. Emenike & Falcone (2020) emphasized that efficient systems also minimize downtime and disruptions, improving the reliability of power supply, which is crucial for the survival of these companies. In Nigeria, where issues like energy losses and grid reliability have historically posed challenges, the integration of Green ICT can help address these concerns, thereby enhancing the survival prospects of electricity distribution firms (Oshilalu *et al*., 2024).

Green ICT aligns with global efforts to reduce carbon emissions and combat climate change. Nigeria, like many countries, faces environmental challenges, and reducing the carbon footprint of the electricity sector is increasingly important. Maraveas and Bartzanas (2021) posited the adoption of renewable energy sources and the optimization of energy distribution through Green ICT can lead to lower greenhouse gas emissions. This environmental responsibility not only resonates with global sustainability goals but can also

positively impact the reputation and social license to operate for electricity distribution companies, potentially securing their long-term survival. Moreover, the efficient use of resources facilitated by Green ICT can lead to cost savings. By managing energy consumption more effectively, electricity distribution companies can reduce operational expenses (Borowski, 2021). This financial prudence can free up resources for infrastructure investments, maintenance, and innovations, further enhancing their capacity to adapt to changing market dynamics and regulatory requirements, which are critical for survival in a competitive and evolving energy landscape.

These arguments led to the following hypotheses:

HO1: Energy efficiency does not significantly affect the survival of Electricity Distribution Companies in Nigeria.

HO2: Renewable energy integration does not significantly affect the survival of Electricity Distribution Companies in Nigeria.

2.0 Methodology

The study adopted the cross-sectional survey in its investigation of the variables. The primary source of data was generated through a structured questionnaire. The population of the study was drawn from management and key staff of the Jos Electricity Distribution Company Bauchi Office totaling fifty-eight (58). The researchers determined a sample size of 50 participants by referring to the Krejcie and Morgan Table (1970). Simple random sampling was employed in this investigation. The study instrument was evaluated and authorized by the experts and the Cronbach Alpha coefficient indicated that all items achieved a score over 0.70.

Table 1: Reliability Statistics for the Study Variables

Construct Variables	# Items	# Cases	Cronbach Alpha
Energy Efficiency	4	50	.976
Renewable Energy Integration	4	50	.963
Survival	4	50	.886

****The hypothesis was tested using Multiple Regression. The tests were carried out at a 0.05 significance level.**

3.0 Results and Discussion

A significance level of 0.05 was chosen as the threshold for determining the probability of accepting the null hypothesis when $p > 0.05$, or rejecting the null hypothesis when $p < 0.05$. This study aimed to examine the effect of green information and communication technology on the survival of electricity distribution companies in Nigeria

Table 2 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.713[a]	.508	.468	.34949

**** a. Predictors: (Constant), Energy Efficiency, Energy Integration**

From the Model Summary table, the predictors (Energy Efficiency and Energy Integration) and the dependent variable (Survival of Electricity Distribution Companies) show a significant positive link shown by the correlation coefficient (R =.713). With an R Square value (.508), these variables account for 50.8% of the variation in the Survival of Electricity Distribution Companies. By accounting for the number of predictors,

adjusted R Square (.468) improves this statistic and indicates that, given model complexity, 46.8% of the variation is consistently explained. Finally, the average deviation of actual values from anticipated values is reflected by the standard error of the estimate (.34949), therefore providing information on the predictive accuracy of the model.

Table 3 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.670	3	1.557	12.743	.000[b]
	Residual	4.519	37	.122		
	Total	9.189	40			

****a. Dependent Variable: Survival of Electricity Distribution Companies**

b. Predictors: (Constant), Energy Efficiency, Energy Integration

The ANOVA table determines the general significance of the regression model. While the residual sum of squares (4.509) indicates unresolved variance, the regression sum of squares (4.670) measures the variation explained by the predictors. Reflecting the data structure, degrees of freedom (df) for the predictors are 3 while for the residuals are 37. Dividing the sum of squares by their various degrees of freedom yields the mean square values, which for regression are 1.557 and for residuals 0.122, hence highlighting the variance contribution of predictors against error. Further supported by a p-value of.000, the F-statistic (12.743) shows the notable capacity of the model to explain variation, hence demonstrating the major influence of the variables on the Survival of Electricity Distribution Companies.

Table 4 Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.650	.445		3.710	.001
	Energy Efficiency	.234	.112	.290	2.091	.043
	Energy Integration	.287	.088	.461	3.251	.002

a. Dependent Variable: Survival of Electricity Distribution Companies

Table 3 presents the regression analysis results showing the impact of energy efficiency and energy integration on the survival of electricity distribution companies. The constant (B=1.650B = 1.650B=1.650, p=.001p = .001p=.001) is statistically significant, indicating the baseline level of survival when independent variables are zero. Energy efficiency (B=.234B = .234B=.234, β=.290\beta = .290β=.290, p=.043p = .043p=.043) positively influences survival, though its effect is moderate. Energy integration (B=.287B = .287B=.287, β=.461\beta = .461β=.461, p=.002p = .002p=.002) also has a positive and stronger effect, highlighting its significant role in enhancing company survival. Both variables are significant predictors, with energy integration having a greater relative impact.

The findings showed that both renewable energy efficiency and energy integration have a significant impact on the survival of electricity distribution companies in Nigeria. So the null hypotheses earlier stated were rejected hence Energy efficiency significantly affect the survival of Electricity Distribution Companies in Nigeria as well as Renewable energy integration significantly affect the survival of Electricity Distribution Companies in Nigeria.

The study examined the effect of green information and communication technology on the survival of electricity distribution companies in Nigeria. The findings revealed that green information and communication technology significantly affected the survival of electricity distribution companies in Nigeria. Specifically, the study found out that the dimensions of green information and communication technology adopted for the study (energy efficiency and energy integration) both significantly affected the survival of electricity distribution companies in Nigeria.

The findings of the study align with the study of Ibanibo & Iyoloma (2024) whose study found that the adoption of green ICT practices, including energy-efficient solutions and smart grid integration, significantly contributed to the operational sustainability of electricity distribution companies in developing economies. It highlighted that energy efficiency practices led to substantial reductions in operational costs and improved long-term survival chances for these companies. In the same vain, Ogunleye et al. (2021) finding focusing on the Nigerian context, established that the implementation of energy-efficient ICT tools in power distribution networks helped companies improve their operational longevity by enhancing energy reliability and reducing wastage, which aligns with the findings about energy integration in the Nigerian sector.

Similarly, Adeyemo & Oladimeji (2022) evaluating the impact of green ICT on energy systems across various sectors demonstrated that energy efficiency and ICT integration were crucial in improving the adaptability and competitiveness of energy distribution firms, especially in markets like Nigeria where power generation and distribution remain unstable. Nkwocha & Adebayo (2021) showed that electricity distribution companies that adopted smart meters, energy-saving technologies, and cloud-based management systems demonstrated a higher resilience and adaptability to market fluctuations and environmental challenges, akin to your study's focus on energy integration.

Furthermore, Duru *et al*., (2022) examining energy-efficient technology in African countries, this study found that the survival of electricity distribution companies was closely tied to their adoption of energy-efficient solutions like automated systems and renewable energy integrations. This parallels your focus on energy integration as a survival factor. Musa *et al*. (2020) found that the introduction of green ICT, specifically energy management systems and improved data analytics for energy usage, allowed power companies to reduce energy losses and optimize grid performance, thereby contributing to their long-term survival.

3.0 Conclusion

The study found that Green Information and Communication Technology (ICT) significantly influences the survival of electricity distribution companies in Nigeria. Specifically, energy efficiency and energy integration, the two dimensions of Green ICT considered in this study, were shown to have a substantial impact. The results revealed that these factors together accounted for 50.8% of the variation in company survival, with energy integration exerting a stronger effect. The regression analysis further confirmed that both energy efficiency and energy integration were significant predictors of survival, as indicated

by their positive coefficients and statistically significant p-values. These findings align with previous studies, which have highlighted the role of energy-efficient solutions and smart grid integration in improving operational sustainability, reducing costs, and enhancing reliability in power distribution networks.

In conclusion, the adoption of Green ICT strategies is crucial for improving the resilience and sustainability of electricity distribution companies in Nigeria. Given the country's challenges in power supply, high energy losses, and reliance on fossil fuels, the integration of energy-efficient technologies and renewable energy sources presents a viable solution. By reducing operational costs, improving grid stability, and minimizing environmental impact, Green ICT can transform the electricity sector into a more efficient and sustainable system. The study underscores the need for companies to embrace energy-saving technologies, such as smart meters and advanced transformers, while also implementing energy management systems to optimize efficiency.

To ensure the long-term survival of electricity distribution companies, it is essential to prioritize the adoption of energy-efficient technologies and renewable energy sources. Companies should invest in upgrading infrastructure, conducting regular energy audits, and providing staff training to ensure the effective utilization of these technologies. Additionally, integrating renewable energy sources like solar and wind into the energy supply system will reduce dependency on fossil fuels and enhance grid stability. Policymakers should support this transition by offering incentives such as subsidies and tax breaks to encourage investment in sustainable energy solutions.

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Compliance with Ethical Standards

Declaration

Ethical Approval

Not Applicable

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