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An Examination Of Green ICT Awareness In Developing Countries

Erick Oteyo Obare
Department Of Information Technology, School Of Computing And Informatics, Maseno University, Kisumu, Kenya.

Abstract
The rapid diffusion of digital technologies across developing countries has fundamentally reshaped economic activity, governance, education, and social interaction. While Information and Communication Technologies (ICTs) have generated significant development gains, their expanding environmental footprint has become increasingly visible through rising energy consumption, greenhouse gas emissions, and escalating volumes of electronic waste. Green Information and Communication Technology (Green ICT) has emerged as a strategic response aimed at minimising the environmental impacts of ICT systems throughout their lifecycle, from design and production to use and end-of-life management. Despite its growing relevance, empirical evidence suggests that awareness of Green ICT concepts and practices remains uneven and relatively low across many developing economies when compared with broader environmental discourses such as climate change or waste management. This paper synthesises academic literature, policy documents, and institutional reports to examine the current state of Green ICT awareness in developing countries. It analyses how awareness is shaped, the barriers that constrain its translation into practice, and the drivers that support its gradual diffusion. The findings indicate that although stakeholders increasingly recognise the environmental implications of ICT expansion, Green ICT is frequently misunderstood, narrowly interpreted, or overshadowed by immediate development priorities such as connectivity, affordability, and infrastructure expansion. Structural challenges including weak regulatory frameworks, limited institutional capacity, financial constraints, and low levels of digital environmental literacy continue to slow progress. However, emerging enablers such as sustainability-oriented education, regulatory incentives, corporate social responsibility initiatives, and international development partnerships are strengthening awareness and adoption intentions. The paper concluds by outlining policy, practical, and research implications for advancing sustainable digital transformation in developing countries.

Keywords: *Green ICT, developing countries, sustainability, environmental awareness, digital literacy, ICT policy, e-waste and technology adoption.*

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I. Introduction

Digital transformation has become a defining feature of socio-economic development in the Global South. Over the past decade, expanding broadband infrastructure, mobile connectivity, cloud computing, and data-driven platforms have significantly altered how individuals, organisations, and governments communicate and operate. In many developing countries, ICTs have facilitated financial inclusion, enabled e-government services, supported remote education, and improved access to global markets. These benefits, however, have been accompanied by environmental consequences that are often insufficiently addressed in policy and organisational practice.

The environmental implications of ICT expansion are increasingly evident. Rising electricity demand from telecommunications networks, data centres, and end-user devices places additional strain on national power systems, many of which remain heavily dependent on fossil fuels. At the same time, shortened device lifecycles, rapid technological obsolescence, and the widespread importation of second-hand electronics have contributed to escalating volumes of electronic waste. Much of this waste is handled through informal recycling systems that expose workers and ecosystems to significant health and environmental risks (Balde et al., 2024).

Green Information and Communication Technology provides a framework for addressing these challenges. Broadly defined, Green ICT encompasses policies, practices, and technologies that seek to reduce the environmental impact of ICT systems across their entire lifecycle. These include energy-efficient hardware and software, sustainable procurement, green data centres, virtualisation, cloud optimisation, and environmentally sound disposal and recycling practices (Hilty & Aebischer, 2021). For developing countries, Green ICT represents not only an environmental imperative but also a potential source of economic efficiency, energy security, and alignment with global sustainability agendas.

Despite this potential, awareness of Green ICT remains fragmented. Policymakers and organisations frequently prioritise expanding access and reducing costs, while environmental considerations are treated as secondary or optional concerns (ITU, 2022). Much of the existing literature focuses on Green ICT initiatives in industrialised economies, leaving a significant gap in understanding how awareness develops and influences behaviour in the Global South. This paper addresses that gap by examining Green ICT awareness in developing countries through a multidisciplinary lens that integrates sustainability theory, innovation diffusion, and organisational analysis.

II. ICT Growth And Environmental Pressures In Developing Countries

The rapid growth of ICT infrastructure in developing countries provides critical context for understanding Green ICT awareness. Internet penetration has increased steadily, driven primarily by mobile broadband technologies and declining data costs. Mobile subscription rates have approached or exceeded population levels in many regions, reflecting market saturation and the prevalence of multi-device ownership. While these trends indicate digital maturity, they also intensify environmental pressures.

One of the most significant environmental impacts of ICT expansion is increased energy consumption. Data centres, mobile base stations, and cloud computing services require continuous power and cooling, particularly in regions with high ambient temperatures. As governments and private organisations digitise services and adopt cloud-based platforms, demand for electricity continues to rise. In countries with limited renewable energy capacity, this growth translates directly into higher carbon emissions.

Electronic waste represents another critical challenge. Rapid device turnover, limited repair culture, and weak recycling systems have resulted in growing volumes of discarded ICT equipment. Formal e-waste recycling rates remain low in many developing countries, with the majority of waste managed informally or exported under questionable conditions (UNEP, 2023). These trends underscore the importance of embedding sustainability considerations into digital development strategies.

Table 1. ICT Growth and Environmental Pressures in Developing Countries (2015–2025)
Sources: ITU (2022); Balde et al. (2024); UNEP (2023)

Indicator	2015	2020	2025 (Projected)	Trend
Internet Penetration	29%	45%	61%	Rapid expansion
Mobile Subscriptions (per 100 people)	82	98	112	Market saturation
Data Centre Energy Use (TWh/year)	28	41	58	Rising load
E-waste Generated (million tonnes/year)	2.2	3.1	4.5	Strong upward trend
Formal E-waste Recycling Rate	7%	10%	14%	Slow improvement

These patterns indicate that without deliberate intervention, ICT-driven development may exacerbate environmental degradation. Awareness of Green ICT is therefore a necessary precondition for sustainable digital transformation.

III. Conceptual And Theoretical Foundations

Understanding Green ICT awareness requires engagement with theoretical perspectives that explain sustainability, innovation diffusion, and organisational decision-making. This paper draws on three complementary frameworks: Sustainable Development Theory, Diffusion of Innovation theory, and the Technology–Organization–Environment (TOE) framework.

Sustainable Development Theory

Sustainable Development Theory emphasises the integration of environmental protection, economic efficiency, and social equity in development processes (UNESCO, 2021). From this perspective, Green ICT contributes to environmental sustainability by reducing energy consumption, lowering emissions, and promoting circular economy practices in electronics management. At the same time, cost savings from energy efficiency and extended device lifecycles support economic sustainability, while access to affordable and reliable digital services enhances social inclusion (Connell & Viola, 2022).

For developing countries facing resource constraints and competing priorities, Sustainable Development Theory highlights the risks of pursuing digital growth without environmental safeguards. Green ICT awareness becomes essential for ensuring that technological progress supports long-term development objectives rather than undermining them.

Diffusion of Innovation Theory

Diffusion of Innovation theory explains how new ideas and practices spread within social systems (Rogers, 2003). According to this framework, awareness represents the first stage of adoption, followed by persuasion, decision, implementation, and confirmation. In the context of Green ICT, awareness involves understanding both the environmental impacts of ICT and the availability of sustainable alternatives.

Empirical studies suggest that Green ICT practices are more likely to diffuse when their advantages—such as reduced energy costs or improved efficiency—are visible and credible (Lau & Wong, 2023). In developing countries, early adopters often include universities, technology hubs, and public sector agencies, which can serve as demonstration sites and influence broader perceptions (Munyoka & Nyembezi, 2024).

Technology–Organization–Environment Framework

The Technology–Organization–Environment framework provides a structured approach to analysing the factors that influence technology adoption at the organisational level (Tornatzky & Fleischer, 1990). It highlights three dimensions: technological characteristics, organisational capabilities, and environmental context. Applied to Green ICT, the framework suggests that awareness alone is insufficient. Organisations must also possess compatible technologies, supportive leadership, adequate resources, and operate within regulatory and market environments that encourage sustainable practices (Alhassan & Adam, 2022).

IV. Barriers To Green ICT Awareness And Implementation

Despite increasing global attention to sustainability, several interrelated barriers continue to constrain Green ICT awareness and adoption in developing countries.

Policy and Regulatory Gaps

Many developing countries lack explicit Green ICT policies or enforceable sustainability standards for the ICT sector. Where regulations exist, enforcement is often weak and fragmented across ministries responsible for ICT, energy, and environmental protection. This fragmentation reduces accountability and weakens incentives for organisations to invest in sustainable practices (ITU, 2022; Olanrewaju & Okoro, 2022).

Infrastructure and Financial Constraints

High upfront costs associated with energy-efficient hardware, renewable energy systems, and modern data centre technologies present significant barriers, particularly for small and medium-sized organisations. Unreliable power supply further complicates adoption, leading many organisations to rely on diesel generators with high environmental costs (Mensah & Fei, 2023; World Bank, 2024).

Institutional and Skills Limitations

Limited technical capacity remains a persistent challenge. Many organisations lack personnel trained in sustainable ICT management, energy auditing, or lifecycle assessment. At the tertiary education level, Green ICT content is often absent or marginal, limiting the development of local expertise (Alhassan & Boateng, 2022).

Low Digital Environmental Literacy

While general environmental awareness may be relatively high, specific knowledge about the environmental impacts of ICT and corresponding mitigation strategies is often limited. Studies from Kenya and other African contexts indicate that many ICT users and managers are unfamiliar with basic sustainable computing practices such as power management, device lifecycle planning, or responsible disposal (Njoroge & Kimani, 2023).

Organisational and Behavioural Factors

Organisational culture and behavioural norms also shape Green ICT awareness. In environments where performance is measured primarily in terms of cost, speed, and service delivery, sustainability considerations may be perceived as secondary. The absence of incentives or recognition for environmentally responsible behaviour further discourages adoption (Ahmed & Khatun, 2024).

V. Drivers Of Green ICT Awareness And Adoption

Despite these challenges, several drivers are contributing to gradual improvements in Green ICT awareness across developing countries.

Economic and Operational Incentives

Rising energy costs have encouraged organisations to reassess the efficiency of their ICT systems. Evidence indicates that virtualisation, cloud optimisation, and energy-efficient servers can yield substantial cost savings, strengthening the business case for Green ICT (Kumar & Singh, 2023).

Policy Instruments and Regulatory Incentives

Governments are increasingly introducing green procurement guidelines, e-waste regulations, and sustainability reporting requirements. Although implementation varies, such policies signal political commitment and raise organisational awareness of environmental responsibilities (UNEP, 2023).

Corporate Social Responsibility and Market Pressure

Large firms and multinational corporations operating in developing countries often integrate sustainability into their corporate social responsibility strategies. These practices can generate spillover effects across supply chains, influencing smaller firms and service providers (Mensah & Boateng, 2024).

Education and Capacity Building

Curriculum integration, professional development programmes, and targeted workshops play a critical role in building Green ICT awareness. Universities, technical institutes, and professional associations are increasingly recognised as key actors in this process (Nyarko & Addo, 2021).

International Development Cooperation

International organisations and development partners support Green ICT initiatives through pilot projects, technical assistance, and policy advisory services. These interventions help local stakeholders translate abstract sustainability concepts into operational practices (UNDP, 2024).

VI. Conclusion And Implications

Green ICT awareness in developing countries is increasing but remains uneven. While stakeholders increasingly recognise the environmental implications of ICT expansion, understanding of concrete sustainable practices remains limited. The analysis demonstrates that awareness alone is insufficient; it must be supported by enabling policies, institutional capacity, and economic incentives to translate into sustained behavioural change.

Policy Implications

Governments should integrate Green ICT explicitly into national digital strategies, energy policies, and environmental frameworks. Coordinated regulatory approaches and regional cooperation can enhance consistency and knowledge sharing.

Practical Implications

Organisations should invest in staff training, adopt energy management practices, and establish responsible e-waste handling mechanisms. Partnerships with civil society and development agencies can support context-specific solutions.

Research Implications

Future research should employ standardised measures of awareness, examine long-term behavioural change, explore cultural influences on adoption, analyse rural–urban disparities in digital environmental literacy, and link Green ICT awareness to circular economy and climate adaptation strategies.

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