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# Developing Effective ICT Governance for Green Computing in Higher Education: Emerging Nations Context

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**A B S T R A C T:**

The global imperative for sustainability necessitates that higher education institutions (HEIs) adopt green computing practices to reduce the environmental impact of ICT. However, successful implementation depends on robust governance structures. This study investigates ICT governance factors influencing green computing adoption in emerging nations, focusing on Burundi. Survey data from 113 ICT personnel across 21 universities were analyzed using descriptive statistics and factor analysis. The results indicate significant governance gaps, with only 18.6% of institutions having formal green computing policies, despite 50.4% of personnel preferring suppliers with green credentials. Factor analysis (KMO = 0.846, Bartlett's $p < 0.001$) revealed two ICT governance components: 'ICT Policies' (51%) and 'Supplier Green Track Record' (49%) explaining 22% of the variance in adoption. These findings emphasize the need for clear policy frameworks, sustainable procurement practices, and institutional accountability to advance green ICT in resource-constrained contexts.

**Keywords:** Green Computing, ICT Governance, Higher Education, Emerging Nations, Sustainability, Environmental Policy, Sustainable Development.

## 1. INTRODUCTION

The proliferation of Information and Communication Technology (ICT) has transformed higher education institutions (HEIs) globally, enhancing teaching, learning, research, and administration. However, this digital dependency comes at an environmental cost. Increased energy consumption by ICT infrastructure and the escalating problem of electronic waste (e-waste) contribute significantly to carbon emissions and environmental degradation (Murugesan, 2008; Oduor & Wabwoba, 2024). Green computing, or Green IT, addresses these concerns by promoting the environmentally responsible design, manufacture, use, and disposal of ICT resources (Katal et al., 2023). Its goal is to minimize the negative environmental impact of technology while maximizing efficiency and sustainability.

While the benefits of green computing, such as reduced energy costs, a lower carbon footprint, enhanced institutional reputation, and compliance with environmental regulations, are widely acknowledged (Chai & Nakata, 2011), its adoption, particularly in emerging nations, faces significant hurdles (Wabwoba et al., 2012). Universities in countries like Burundi, while recognizing the potential of ICT, often lag in adopting sustainable practices due to factors such as perceived costs, lack of technical capacity, and, crucially, inadequate ICT governance (Babalola & Genga, 2024). The urgency is underscored by global initiatives like the Greening Education Partnership, which aims to prepare every learner for climate action and support institutions in operating sustainably (UNESCO, 2024).

ICT governance encompasses the leadership, structures, and processes ensuring that an organization's ICT sustains and extends its strategies and objectives (Bianchi & Sousa, 2015; Chulkov & Yishan, 2011). In the context of green computing, effective ICT governance provides the framework for integrating sustainability into ICT operations, procurement, and lifecycle management. It involves establishing clear policies, defining responsibilities, managing risks, and ensuring that ICT investments align with environmental goals (GROWTH Project, 2024). The absence of such governance can lead to fragmented efforts, inefficient resource use, and a failure to realize the potential benefits of green computing.

This study aims to address the critical role of ICT governance in facilitating green computing adoption within HEIs in emerging nations. It employs a survey research design, involving a questionnaire administered to ICT personnel across 21 universities in Burundi. The study seeks to:

- Assess the current state of ICT governance practices related to green computing in Burundian universities.
- Identify key ICT governance factors influencing green computing adoption in Burundian Universities.
- Propose effective ICT governance strategies for improvement tailored to the context of HEIs in emerging nations.

By analyzing the specific challenges and opportunities related to ICT governance in this context, this study contributes to developing practical strategies for fostering sustainable ICT practices in higher education across emerging economies, aligning with global sustainability imperatives (UNESCO-IESALC, 2024).

## 2. PROBLEM STATEMENT

Higher education institutions (HEIs) in emerging nations face increasing environmental impact from their growing reliance on Information and Communication Technology (ICT). While green computing offers solutions to mitigate this impact, its adoption is often hindered by inadequate ICT governance structures. This study investigates the role of ICT governance in facilitating green computing adoption within HEIs in emerging nations, specifically focusing on universities in Burundi, to identify key governance factors and propose effective strategies for improvement.

## 3. LITERATURE REVIEW

### *3.1 GREEN COMPUTING IN HIGHER EDUCATION*

Higher education institutions are significant consumers of ICT resources and, consequently, major contributors to energy consumption and e-waste (AICTE, 2013). The adoption of green computing practices is thus crucial for these institutions to mitigate their environmental impact, reduce operational costs, and fulfill social responsibility mandates. Initiatives range from energy-efficient hardware procurement (e.g., Energy Star certified devices) and power management software to virtualization, cloud computing adoption, promoting paperless practices, and responsible e-waste recycling and disposal (Murugesan, 2008; Suryawanshi & Narkhede, 2014). Recent trends emphasize a holistic "green campus" approach, integrating sustainability into operations, infrastructure management, and community engagement (UNESCO-IESALC, 2024; GROWTH Project, 2024). Studies highlight benefits such as cost savings, enhanced institutional image, and contribution to environmental sustainability (Chai & Nakata, 2011). However, barriers persist, including lack of awareness, insufficient funding, lack of training, and inadequate policies and government regulations, especially in developing countries (Wabwoba et al., 2012; Babalola & Genga, 2024). The Greening Education Partnership highlights the need for systemic change, including greening schools and curricula (UNESCO, 2024).

### *3.2 ICT GOVERNANCE*

ICT governance is recognized as an integral aspect of corporate and institutional governance, ensuring that ICT deployment aligns with organizational goals, manages risks, and delivers value (Chulkov & Yishan, 2011). Frameworks like COBIT and ITIL provide structures, but implementation varies. Effective ICT governance involves clear decision-making authority, defined roles and responsibilities, strategic alignment, performance management, and resource management (Bianchi & Sousa, 2015; Haes & Grembergen, 2009). Research in universities, such as the study by Bosco et al. (2016) at the University of Rwanda, has shown a positive relationship between strong ICT governance and strategic alignment, performance, and resource management. However, applying generic frameworks often requires adaptation to the specific context of HEIs, considering factors like decentralized structures, academic freedom (Martin & Gregor, 2008), and specific challenges faced in regions like Africa regarding digital transformation management (Babalola & Genga, 2024). A Libyan case study also highlights the importance of understanding how governance models evolve and influence ICT effectiveness in HEIs (Saleh et al., 2024).

### *3.3 ICT GOVERNANCE FOR GREEN COMPUTING*

The intersection of ICT governance and green computing involves establishing policies and controls specifically aimed at environmental sustainability within ICT operations. This includes defining green procurement criteria (James & Hopkinson, 2009; Molla, 2008), setting standards for energy consumption and power management (Pazowski, 2015), mandating e-waste disposal procedures (Debnath et al., 2016; Murugesan, 2008), and assigning responsibility for monitoring and reporting on green ICT metrics. Governance structures ensure that green ICT initiatives are not ad-hoc but are integrated into the institution's overall strategy and management processes (Murugesan & Gangadharan, 2008; GROWTH Project, 2024). Key elements identified include top management support, clear policies, assigned responsibilities (for instance, a Green Computing Committee, as suggested by Suryawanshi & Narkhede, 2014), and alignment with broader institutional sustainability goals. Recent analyses stress that regulatory pressures and policy frameworks are crucial drivers for green computing adoption globally (Oduor & Wabwoba, 2024). Studies suggest that integrating green principles into ICT governance frameworks is essential for driving meaningful adoption.

### *3.4 CHALLENGES IN EMERGING NATIONS*

Implementing effective ICT governance for green computing presents unique challenges in emerging nations. These often include limited financial resources, a lack of skilled ICT personnel with green expertise (Wabwoba et al., 2013), inadequate national policy frameworks or enforcement (Saleh et al., 2024), lower levels of awareness regarding environmental impacts, and infrastructural limitations (Teferra & Altbach, 2004; Babalola & Genga, 2024). Research highlights the need for context-specific frameworks that consider these constraints (Molla et al., 2008). The data collected universities in Burundi provides a case study illustrating these challenges, showing disparities in policy existence and implementation. Furthermore, broader issues like digital divides, governance instability, and infrastructure gaps compound these difficulties in many African nations (UNCTAD, 2024; E-Governance

Knowledge Hub, 2025). Therefore, developing governance models applicable to HEIs in emerging nations requires addressing these specific socio-economic, political, and technical realities.

## 4. Methodology

This study employed a survey research design, considered suitable for its adaptability and broad applicability to evaluate the factors influencing green computing adoption in Burundian universities. The research focused on the ICT departments of all 21 registered public and private universities in Burundi, utilizing a census approach targeting 126 ICT personnel. Data was collected via electronic questionnaires assessing ICT governance practices, among other factors, using a 5-point Likert scale. Factor analysis was used to identify the key variables contributing to green computing based on the collected data. The Kaiser-Meyer-Olkin (KMO) measure (yielding a value of 0.846) (Kaiser & Henry. 1970) and Bartlett's test of sphericity confirmed the data's appropriateness for factor analysis (Bartlett, 1950). Principal Component Analysis and factor rotation were subsequently used to extract and interpret the underlying components related to ICT governance factors influencing green computing adoption. Future studies could improve upon this study's methodology by incorporating structural equation modeling (SEM) to evaluate mediating and moderating variables such as leadership support, policy enforcement mechanisms, financial resources, technical expertise, and institutional readiness, thereby providing a more comprehensive model of green computing adoption.

## 5. RESULTS AND FINDINGS

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This section presents the key findings specifically related to ICT Governance factors for green computing adoption, derived from 113 ICT personnel across 21 Universities in Burundi, which were analyzed using descriptive statistics and factor analysis.

### *5.1 Descriptive Findings on ICT Governance Practices*

Analysis of responses revealed a mixed picture regarding ICT governance for green computing. A significant portion of respondents disagreed that their university had specific policies related to green computing. Specifically, 46.0% disagreed or strongly disagreed that their university has a policy regarding green computing for sustainability, 41.6% disagreed or strongly disagreed that their university has a green computing policy on its agenda, and 51.3% disagreed or strongly disagreed that there is a policy on employees' use of ICT in an energy-efficient manner.

However, there was stronger agreement on some specific, potentially policy-driven actions, as 56.7% agreed or strongly agreed that their university has a policy stating staff should turn off computers when not in use. Attitudes towards green ICT suppliers were somewhat positive but lacked strong institutional backing: 50.4% agreed or strongly agreed that they prefer ICT suppliers with a green track record, yet 43.3% disagreed or strongly disagreed that their university actively advocates for green computing adoption by potential ICT suppliers. These descriptive results suggest that while there might be individual preferences or specific rules (like turning off PCs), overarching, formalized ICT governance structures and policies specifically promoting green computing are largely lacking or not well-communicated in the surveyed universities.

### *5.2 Factor Analysis Findings on ICT Governance*

Table 5.1 presents the variables weights that contributed towards ICT governance factors as in Table 5.1.

**Table 5.1:** ICT Governance Factors Loadings

| | ***Loading*** | |
|---|---|---|
| **Factors** | ***Component 3 (ICT Policies)*** | ***Component 7 (Supplier Green Track Record)*** |
| **ICT Policies** | | |
| Advocacy of supplier green computing adoption | *0.778* | |
| ICT energy efficiency policy | *0.676* | |
| PC turn off policy | *0.680* | |
| **Supplier with Green track record** | | *.685* |

Relying on the findings in Table 5.2, it's noted that the items "My university advocates the adoption of green computing by potential ICT suppliers" that was summarized as "Advocacy of supplier green computing adoption" had a factor loading of .778, "There is a policy on employees 'use of ICT in an energy-efficient manner" that was summarized as "ICT energy efficiency policy" had a factor loading of .676, and "My university has a policy that states staff should turn off computers when not in use" that was summarized as "PC turn off policy" had a factor loading of (.680) upon component 3. Component 3 was named ICT policies with its weight obtained as $(\frac{.778+.676+.680}{3}) = .711$. The item "Preference of ICT suppliers that have a green track record" summarized as supplier green track record had a factor loading of .685 load on component 7 that was named supplier green track record. The components 3 and 7 were combined based on their policy aspects with the resultant combination being ICT governance Factors.

The ration of Advocacy of supplier green computing use adoption, ICT energy efficiency policy and PC turn off policy contribution towards ICT policies was respectively obtained as $(\frac{.778}{.778+.676+.680}) = .365$, $(\frac{.676}{0.778+0.676+0.680}) = .317$ and $(\frac{.680}{.778+.676+.680}) = .319$. At the same time ratios of ICT Policies and supplier green track record contribute to the ICT governance as $(\frac{.711}{(.711+.685}) = .510$ and $(\frac{.685}{.711+.685}) = .490$ respectively.

To sum up, the components identified were ICT Policies and Supplier with Green Track Record, which together contribute to ICT Governance Factors. The combined ICT Governance factor, comprising 'ICT Policies' (51%) and 'Supplier with Green Track Record' (49%), showed that governance practices are integral to green computing adoption, accounting for 22% of the overall variance in adoption.

### *5.3 Contribution of ICT Governance Framework*

Table 5.2 presents the variables weights that contributed towards ICT governance framework as in Table 5.2.

**Table 5.2:** ICT Governance Factors Variables Weights

| ICT Governance Factors | Loading | Total Loading | Avg Load | Weight | |
|---|---|---|---|---|---|
| ICT Policies | | .711 | | | **.509** |
| Supplier Green track record(ictgv2) | .685 | 1.396 | | .698 | **.491** |

Figure 5.1 can also graphically be represented as indicated in the figure below:

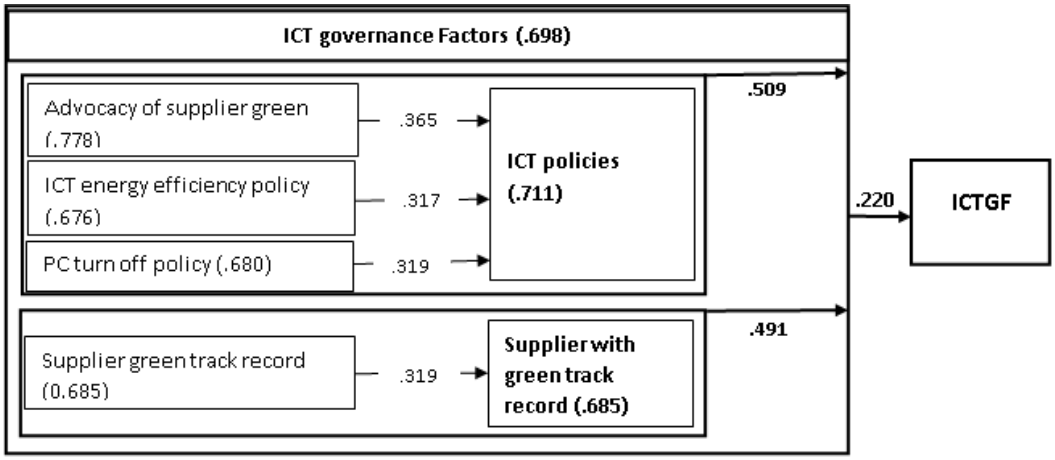


**Figure 5.1:** ICT Governance Factors Framework

The combined ICT Governance factor, comprising 'ICT Policies' and 'Supplier Green with Track Record'. The average weight of the ICT Governance construct was calculated as .698. Within this construct, 'ICT Policies' contributed 50.9%, and 'Supplier with Green Track Record' contributed 49.1%. Overall, ICT Governance Factors accounted for only 22% of the variance in adoption is explained by ICT governance factors. Future studies could integrate additional dimensions like leadership support, budget allocations, and institutional culture to build a more holistic model. These findings empirically establish that ICT governance, encompassing both policy formulation and supplier management, is a distinct and important dimension influencing the potential for green computing adoption in the context studied. The relatively balanced contribution suggests both internal rules and external relationships are key leverage points.

## 5. DISCUSSION

The findings present a compelling picture of the state of ICT governance for green computing in Burundian universities, likely reflecting challenges common to HEIs in other emerging nations. The data indicates a significant gap between the recognized need for sustainable practices (evidenced by personnel preference for green suppliers) and the existence of formalized governance structures to mandate and support them. Institutional Culture and Leadership Gaps: The relatively low explained variance implies other critical drivers of green computing adoption, such as top-level commitment, performance incentives, and staff empowerment, may be absent or unmeasured.

The factor analysis confirmed 'ICT Policies' and 'Supplier with Green Track Record' as the core components of ICT governance. The significant loading of items related to energy efficiency policies and supplier advocacy under 'ICT Policies' underscores the importance of institutional directives. Universities need to move beyond individual actions and establish clear guidelines for energy use, procurement, and potentially, supplier engagement regarding green practices. The distinct factor related to 'Supplier with Green Track Record' highlights procurement as a critical governance lever. Only 22% of the variance in adoption is explained by ICT governance factors. Future studies could integrate additional dimensions like leadership support, budget allocations, and institutional culture to build a more holistic model. This would help to capture the full spectrum of influences on green computing adoption in HEIs.

## 7. CONCLUSION

This study, leveraging data from universities in Burundi, underscores the critical yet partial role of effective ICT governance in advancing green computing adoption within higher education institutions in emerging nations. While awareness and individual preferences for sustainable practices may exist among ICT personnel, significant gaps persist in the formal policies and governance structures needed to translate these into consistent, institution-wide action. The findings highlight a lack of comprehensive green computing policies related to sustainability strategy, energy efficiency, and supplier management in the majority of surveyed institutions.

Factor analysis identified 'ICT Policies' and 'Supplier with Green Track Record' as key components of ICT governance in this context, contributing almost equally to the construct. However, these governance elements together explained only 22% of the variance in green computing adoption. This signifies that while effective ICT governance acts as an essential enabler, providing necessary direction and control mechanisms, it must be complemented by addressing other significant factors such as leadership commitment, institutional culture, resource availability, and technical capacity to achieve widespread and impactful green computing implementation in HEIs within emerging economies.

## 8. RECOMMENDATIONS

Based on the findings, several actions are recommended for HEIs in emerging nations to enhance green computing adoption through effective ICT governance. Institutions should prioritize establishing clear policies addressing energy efficiency, equipment usage guidelines, responsible printing standards, and e-waste management. Clear governance structures should be established by defining specific roles and responsibilities for overseeing green ICT initiatives, potentially through a dedicated committee or by assigning duties within existing structures. Policy implementation should be supported with awareness campaigns and targeted training for all university members on energy-saving practices and the rationale behind green computing. Monitoring and reporting mechanisms should be implemented to establish basic metrics for tracking progress (e.g., energy consumption, recycling rates) and ensure accountability. Finally, governance measures should be contextualized to adapt to the specific financial, infrastructural, and human resource realities of the institution and the emerging nation context, allowing for phased implementation.

By addressing these recommendations, HEIs in emerging nations can leverage effective ICT governance to drive meaningful and sustainable green computing adoption, contributing to their environmental and institutional goals.

### *9. ACKNOWLEDGEMENT*

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### REFERENCES

1. AICTE. (2013). *AICTE Manual*. www.aicte-india.org
2. Babalola, S. S., & Genga, C. A. (2024). Managing Digital Transformation in African Higher Education Institutions: Challenges and Opportunities. *International Journal of Educational Development in Africa*, *9*(2), 1-19. https://doi.org/10.25159/2312-3540/1333
3. Bartlett, M. S. (1950). Tests of Significance in Factor Analysis. *British Journal of Statistical Psychology*, *3*, 77-85. https://doi.org/10.1111/j.2044-8317.1950.tb00285.x
4. Bianchi, I. S., & Sousa, R. D. (2015). IT governance for public universities: Developing a model. *Proceedings of the 10th Iberian Conference on Information Systems and Technologies (CISTI)*.
5. Bosco, J., Ndushabandi, N., & Wausi, A. N. (2016). ICT Governance Drivers and Effective ICT Governance at the University of Rwanda. *American Journal of Information Systems*, *4*(2), 45–58. https://doi.org/10.12691/ajis-4-2-
6. Chai, A., & Nakata, K. (2011). The Evolution of Green ICT Practice: UK Higher Education Institutions Case Study. *IEEE International Conference on Green Computing and Communications*, United Kingdom, 220–225.
7. Chulkov, Z., & Yishan, N. (2011). *ICT Governance in the United Nations System Organizations*. Joint Inspection Unit, United Nations.
8. Debnath, B., Roychoudhuri, R., & Ghosh, S. K. (2016). E-waste management — A potential route to green computing. *Procedia Environmental Sciences*, *35*, 669–675.

9. E-Governance Knowledge Hub. (2025). *African Countries E-Gov Challenges & Solutions*. Retrieved April 15, 2025, from https://e-governancehub.ru/african-countries-e-gov-challenges/

10. GROWTH Project. (2024). *Policy brief "Towards green university"*. University of Banja Luka. https://growth.ubn.rs.ba/wp-content/uploads/2024/10/D5.2-Policy_brief_Towards_green_university_ENG.pdf

11. Haes, D., & Grembergen, V. (2009). An exploratory study into IT governance implementations and its impact on business/IT alignment. *Information Systems Management*, *26*(2), 123–137.

12. James, P., & Hopkinson, L. (2009). *Sustainable ICT in Further and Higher Education - A Report for the Joint Information Services Committee (JISC)*. Suste IT, London, UK.

13. Kaiser, H. F. (1970). A second generation little jiffy. *Psychometrika*, *35*(4), 401–415. https://doi.org/10.1007/BF02291817

14. Katal, A., Wazid, M., & Goudar, R. H. (2023). Big data: Issues, challenges, tools and good practices. *2013 Sixth International Conference on Contemporary Computing (IC3)*, 404–409.

15. Martin, N., & Gregor, S. (2008). ICT Governance Frameworks for Managing Australian e-Government. *Journal of E-Government*, *2*(3/4), 40–49. https://doi.org/10.1300/J399v02n03

16. Molla, A. (2008). GITAM: A model for the Adoption of Green IT. *19th Australian Conference on Information Systems*, Christchurch, Australia, 658–668.

17. Murugesan, S. (2008). Harnessing Green IT: Principles and Practices. *IT Professional IEEE Computer Society*, *10*(1), 24–33.

18. Murugesan, S., & Gangadharan, G. (2008). *Harnessing Green IT: Principles and Practices*. Wiley-India.

19. Oduor, O. P., & Wabwoba, F. (2024). The evolution of green computing: Current practices and societal implications. *World Journal of Advanced Engineering Technology and Sciences*, *13*(02), 541–548. https://doi.org/10.30574/wjaets.2024.13.2.0622

20. Pazowski, P. (2015). Green Computing: Latest Practices and Technologies For ICT Sustainability.

21. Saleh, M. A., Zualkernan, I. A., & Al-Dhaqm, A. (2024). ICT Governance in Higher Education: A Case Study of a Vocational College in Libya. *SHS Web of Conferences*, *187*, 04015. https://doi.org/10.1051/shsconf/202418704

22. Suryawanshi, K., & Narkhede, S. (2014). Green ICT at Higher Education Institution: Solution for Sustenance of ICT in Future. *International Journal of Computer Applications*, *107*(14), 35–38.

23. Teferra, D., & Altbach, P. G. (2004). African higher education: Challenges for the 21st century. *Higher Education*, *47*(1), 21–50.

24. UNCTAD. (2024). *Economic Development in Africa Report 2024*. United Nations. https://unctad.org/publication/economic-development-africa-report-2024

25. UNESCO. (2024). *Greening every school*. UNESCO. https://www.unesco.org/en/sustainable-development/education/greening-future/schools

26. UNESCO. (2024). *Greening Education Partnership*. UNESCO. https://www.unesco.org/en/sustainable-development/education/greening-future

27. UNESCO-IESALC. (2024). *New brief on green campuses released*. UNESCO International Institute for Higher Education in Latin America and the Caribbean. https://www.iesalc.unesco.org/en/articles/new-brief-green-campuses-released

28. Wabwoba, F., Wanyembi, W. D., & Omuterema, S. (2012). Barriers to green ICT implementation in Kenya. *International Journal of Science and Technology*, *2*(12), 823–836.

29. Wabwoba, F., Wanyembi, W. D., Omuterema, S., & Omieno, K. K. (2013). Green ICT Readiness Model for Developing Economies: Case of Kenya. *International Journal of Advanced Computer Science and Applications (IJACSA)*, *4*(1), 51–65. https://doi.org/10.14569/ijacsa.2013.040108