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Institutional stakeholder perceptions of barriers to Green IT policy in Nigeria

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Abstract

This article inductively identifies barriers and limitations to Green IT policy as perceived by IT and environmental regulators in Nigeria. Qualitative interviews were conducted with the set of senior executive managers of Nigerian regulators who share Green IT as a key remit. The data were analysed using inductive thematic analysis. Although mostly reactive, Green IT policy in Nigeria has mainly targeted e-waste and incentivized innovative uses of renewable energy. However, insufficient financial provision towards the promotion of Green IT was perceived to hinder efficient regulatory activities. Similarly, poor energy infrastructure and insufficient collection and recycling facilities prevented the regulators from enforcing Green IT strategies. Major impeding barriers were also reported at the levels of policy ownership and control. This article is valuable to public administration agencies who must collaborate to address the issues of information technology/information systems and sustainability. It exposes regulators' perceived difficulty to establish lines of accountability between agencies that intervene in Green IT policy, from the perspective of a developing country. Each regulator is currently focused on taking individual efforts and steps which are perceived to lead to conflict in policies and overlapping authority. As remedial action we propose tighter coordination amongst regulators who share Green IT as a key remit.

Keywords

Green IT

policy

regulators

barriers

Nigeria

stakeholders

e-waste

energy infrastructure

1. Introduction

Growing concerns over the environmental impacts associated to a global increase in the use of Information Technology (IT) have in recent years stimulated the production of Green IT policy, i.e. policy specifically created to govern all stages of the IT life cycle (Murugesan 2010) with a view to reducing consumption, saving costs, lowering environmental impact, improving systems performance and saving space (Colomo-Palacios 2015). In other words, Green IT comprehends the 'design, production, sourcing, use and disposal of IT' (Molla, Cooper and Pittayachawan 2009) in an environmentally conscious way. This involves the use of environmentally friendly elements in the design and production of IT equipment, ensuring it is energy efficient, encouraging energy saving measures, environmentally friendly disposal of IT equipment and the use of IT to promote sustainable behaviours and actions.

Research has shown that developing countries have been slow in addressing environmental issues, more so in relation to IT (Houghton 2009; Wabwoba et al. 2012). However, according to Mertz et al. (2009), developing countries are amongst

the most vulnerable and exposed to the effects of climate change, as they are typically prone to high temperatures and rely heavily on agriculture. While several studies have focused on Green IT readiness (e.g. Chen and Chang 2014; Uddin and Rahman 2012) and on Green IT adoption and assimilation at organizational level (e.g. Bose and Luo 2012; Cooper and Molla 2014; Rahim and Rahman 2013), the challenges faced by IT and environmental regulators in developing countries when promoting and enforcing Green IT appear to be neglected by the literature.

This article seeks to address that gap by endeavouring to inductively identify barriers and limitations to Green IT policy as perceived by relevant regulators in the specific context of Nigeria. This is particularly relevant for the theory and practice of IT sustainability (Standing and Jackon 2008), as Green IT policy engineering has been found to be instrumental in encouraging firms and the society at large to enact environmentally sustainable behaviours (Dedrick 2010; Chen et al. 2009; Molla et al. 2009).

In what follows, we review the literature on institutional approaches to environmental governance, and Green IT. Subsequently, we introduce and describe the research methods employed in the study. We then present the emergent themes inductively extracted from the regulators' conceptions. The article closes with a discussion of findings and an examination of theoretical and practical implications.

2. Literature review

This section begins with an overview of the existing literature on institutional approaches to environmental governance. It then moves on to an appraisal of the

concept of Green IT, with emphasis on the issues of policy and regulation. It begins with an acknowledgement of the negative environmental impacts of IT and then moves on to discuss the concept of Green IT as a solution. The role of regulators and Green IT policy in ensuring Green IT adoption and implementation is subsequently introduced. The review closes with an overview of Green IT strategies in both developed and developing countries.

2.1 Institutional approaches to environmental governance

A detailed review of theory and practice of environmental governance is beyond the scope of this article. However, an understanding of environmental governance informed by institutional theory (North 1990; Wheeler 2004) can illuminate the ways in which administrative bureaucracies and the professional allegiances of government agencies in different sectors may impact cross-sector coordination for planning and implementing Green IT policy. Indeed it has been argued that the make up of institutional conditions plays an important role in shaping the ways in which institutional actors make decisions and take actions (Nilsson and Persson 2003; Kalantaridis and Fletcher 2012).

The traditional system of public management is typically composed of fragmented sectors of decision-making and implementation, which is at odds with increasing needs to foster integration, coordination and communication between institutions and actors, particularly in the context of environmental governance (Volkery et al. 2006). This section of the review synthesizes core principles extracted from the literature on environmental governance that break away from the traditional command and control approach that dominated the so-called first generation of

environmental and natural resource policies. The latter are epitomized by isolated, centralized authority agencies (Durant et al. 2004), and have been challenged by calls for the managerial reform of existing governance regimes. The possibilities of reform can assume several formats or modalities: integrated management (e.g. Born and Sonzogni 1995; Margerum and Born 2000); collaborative management (e.g. Koontz et al. 2004; Emerson et al. 2012); adaptive management (e.g. Walters 1986; Folke et al. 2005); and results-oriented management (e.g. Durant 1999).

Integrated management proposes to overcome fragmented approaches to the management of environmental resources through focusing on the integrity of an ecological system as opposed to the singularity of individual resources (Grumbine 1997). This entails enhanced sensitivity to a variety of ecological and socio-economic factors that are subsequently appraised in their interconnectedness and reduced to a reasonable scale of objectives that management activities must address (Born and Sonzogni 1995). The required synthesis and coordination effort is of a very high level, as different management authorities, knowledge arenas, stakeholder values, resources and interests must be placed in interaction (Cortner and Moote 1999).

Collaborative management is concerned with providing adequate participation mechanisms for stakeholder engagement in agency decision-making (van Bueren et al. 2003; Irvin and Stansbury 2004). In operational terms collaborative environmental management develops through networks that collect and integrate the knowledge and authority of disperse entities (public agencies, private and non-governmental agents), which are required to address complex policy problems. However, immersion within and management of collaborative networks is particularly challenging for public agencies that remain bound to institutional hierarchy and devote limited time to

network participation (Agranoff 2006). In particular, governmental agencies' bureaucratic processes, fierce defence of resources and turf and different management strategies are long-standing barriers to collaboration as they prevent knowledge and resource sharing, and confound the joint decision-making process that is required to address cross-jurisdictional issues (Wondolleck and Yaffee 2000).

Adaptive management proposes to maximize scientific learning through iteratively mobilizing new knowledge of environmental conditions and societal needs, acquired scientifically and disseminated through social learning (McLain and Lee 1996). This knowledge is then applied to swiftly adjust management strategies, following a structured process of learning by doing (Walters and Holling 1990) that overcomes the limitations of trial and error approaches. This approach is challenging for government agencies that traditionally operate in an environment of budget-constrained short-term planning cycles (Stankey et al. 2003), high risk intolerance and dominant working culture values that limit the ability to actively reflect and learn (Allan and Curtis 2005; Allan et al. 2008).

Finally, results-oriented management proposes a shift away from the measurement of administrative outputs that are excessively procedural, critical resource-absorbing and arguably limited in their ability to determine whether or not any kind of environmental improvement occurred and is an impact of agencies' actions. Instead of focusing on the traditional programme output measures (e.g. permits issued, inspections undertaken), the focus is on targeted societal and environmental outcomes as accountability measures, which requires designing reliable indicators that not only track environmental impact but are also able to

demonstrate the link between programmes and observable improvements (Radin 2006).

The perspectives on environmental governance discussed above all aim to improve the inadequacies of bureaucratic and hierarchical environmental management. A further important commonality is the fact that they challenge a traditional view of institutions as government machinery driven by formal rules (Peters 2000) and reflect an emphasis on the mutual intreaction that occurs between institutions and their actors' cognition, culture and values (Giddens 1984; North 1990; Powell and DiMaggio 2012), which reinforces the importance of institutional actors (Wheeler 2004), and subsequently the relevance of investigating institutional stakeholder perceptions of barriers to Green IT policy.

2.2 IT and environmental problems

The gradual degradation of the environment has led to an increase in extreme weather conditions such as droughts and the rising levels of the sea, and it has promoted a decline in food and water resources (vom Brocke et al. 2013). Accordingly, the growing need for sustainable development in order to control climate change and its environmental impacts has made organizations become more aware of the impact their processes could have on the environment (Brooks et al. 2012). In this context, the use of computers and other forms of IT has become the focus of greater scrutiny, as it tends to consume large amounts of electricity, which in turn leads to an increase in greenhouse gas emissions (Murugesan 2008). Reconciling this realization with a global demand for technology and widespread use of various kinds of IT equipment has become a critical issue for regulators and policy-makers. On the one hand, the

introduction of IT generates positive economic development effects, but on the other hand there is the mounting increase in CO2 emissions (Brooks et al 2012).

The ICT industry is currently responsible for 2% of CO2 emissions, which is approximately the same as the aviation industry (Gartner 2007). According to Ruth (2009), a fundamental problem is the high rate at which these emissions from IT are increasing, which happens to be faster than other sources of carbon emissions. As organizations rely on IT to drive operation, there has been an increase in the need for establishing data centres. The consequence of these developments has been a high increase in energy and power utilization to maintain those IT infrastructures (Sarker and Young 2009). The cooling of data centres to ensure operationality is particularly energy-intensive (Uddin and Rahman 2011). In 2007, Gartner analysed the source of emissions caused by the IT industry and concluded that 40% of the emissions were caused by PCs and monitors and 23% were attributed to data centres. The figures will be different today, but not necessarily more optimistic. The Global eSustainability Initiative (GeSI 2008) estimated that 70% of the population in developing countries would have access and would afford ICT devices by 2020, catching up with that of developing countries. It would also contribute to about 60% of the total carbon emissions from ICT.

Indeed, various factors contribute to the global expansion of the negative impacts of IT, namely an increased use of IT equipment in developing countries, an increasing demand for data centres in developing countries, and an increasing use of metal in the manufacture of IT devices, which poses recycling challenges (Graedel et al. 2011). The improper disposal of IT equipment after use is a major cause for

concern (Basel Convention 2011). Approximately 50 million tons of harmful and toxic waste from IT is not properly disposed after use, leading to an increase in the levels of pollution (Lei and Ngai 2013). Developing countries suffer most from this as they are the main importers of used IT equipment, most of which is already waste (Basel Convention 2011).

The combination of these factors determines that developing countries need to consider the development of green policy instruments to 'accelerate progress towards sustainable development and poverty reduction' (OECD 2012).

2.3 Green IT

The range of negative environmental consequences associated with the growing use of IT at a global level has created the need for a more sustainable use of IT equipment. The concept of Green IT encapsulates this concern with the several environmental consequences of IT at the various stages of its life cycle, as observable in the definition proposed by Murugesan (2010): 'Green IT, also known as Green Computing, refers to the study and practice of designing, manufacturing, and using computer hardware, software, and communication systems efficiently and effectively with no or minimal impact on the environment'.

This definition reflects an integrated view of the IT equipment life cycle, throughout which environmental requires must be met: the design of IT devices should ensure their energy efficiency; the devices' manufacturing process should pose minimal or no risk to the environment; the devices' energy consumption should be reduced and controlled; the disposal of devices should involve proper refurbishing or effective recycling (Murugesan 2010). Similar concepts such as 'environmentally

friendly IT', 'green ICT', 'green computing', 'green information systems' are equally concerned with the establishment of standards and practices that promote the eco-sustainable use of IT (Murugesan 2008; Brooks et al 2012; Tushi et al. 2014).

Initially the concept of Green IT was perceived to be mostly geared towards energy saving, which may be related to the United States Environmental Protection Agency's (USEPA) creation of international standards for energy efficient consumer products, since the early 1990s (Brooks et al. 2012). However, the use of the term evolved over time to cover the design, use and disposal of IT equipment in an environmentally friendly manner, as well as the development of sustainable software and communications systems that can be used to induce energy saving behaviours in organizations (Watson et al. 2008; Chen et al. 2008). Broader definitions of Green IT reflect a concern with the optimal use of IT to ensure sustainability across enterprise operations and the supply chain (Gartner 2007), but the unifying element in the variety of existent definitions is the concern with the minimization of environmental impact and the promotion of sustainable behaviour (Harmon and Auseklis 2009; Molla 2009a; Lei and Ngai 2013).

Green IT has demonstrated to be a promising solution for the reduction IT environmental impacts, and was a major topic of discussion at the United Nations Climate Change Conference in 2009 (Brooks et al. 2012). Furthermore, the benefits resulting from the adoption of Green IT have been experienced by organizations and governmental authorities. In Australia, the mandatory shutdown of personal computers when not in use has helped reduce emissions and save power. This has affected about 50,000 personal computers, which saved CO_2 emissions of up to

30,000 tonnes annually, the equivalent to taking 3500 cars out of the road (Reimsbach-Kounatze 2009). In the corporate context, organizations such as HP and Nokia have increased their energy savings reduced greenhouse gas emissions through the introduction of Green IT strategies. HP has been able to reduce the energy consumption of their devices by 50 per cent in 2012 compared to its consumption in 2005, whilst Nokia implemented a voluntary take back scheme of old devices that collected 60 tons of equipment in 2011 (Greenpeace 2012).

2.4 The role of regulators and Green IT policy

Research on Green IT policy drivers has revealed the enabling role played by two main factors, namely external regulation and customer influence (Sarker and Young 2009). In their study of Green IT at large higher education institutions and top IT firms, Sarker and Young (2009) considered that the availability of a legal framework is not persuasive enough in the shaping of organizations adoption of Green IT policy if it is not matched by mandatory enforcement by regulators.

On the other hand, for regulation to be effective, there is the need for continuous availability of information and the control and monitoring of pollution levels and energy consumption patterns (Reimsbach-Kounatze 2009). In a similar vein, Houghton (2009) emphasizes the need for efficient information flows to promote Green IT, since an evidence-based approach is 'the key to enabling people to make more sustainable choices and realize benefits from their actions, as well as for education, awareness and support'. When prompted to reflect on the range of factors that determine the adoption of Green IT organizations typically place IT cost-reduction and corporate strategy at the top of the list (Molla et al. 2009). Conversely,

when asked to consider inhibitors of Green IT adoption, organizations identify insufficient governmental incentives and poor training as the main limitation (Molla et al. 2009).

However, in an appraisal of Green IT readiness, i.e. the input, transformational and output capabilities that organizations need to hold for the sustainable management of IT, Molla et al. (2008, 2011) highlight the critical importance played by economic drivers, ethical drivers and regulatory drivers. Economic drivers refer to the need to achieve cost savings from the use of IT. Ethical drivers are related to the conduit of socially responsible business practices. Finally, regulatory drivers refer to the influence exerted by regulatory bodies and the government, which tends to be more effective in the presence of constant monitoring and mandatory compliance.

The pressure to comply with regulations can indeed effect change, as organizations are forced by governments to adopt new practices and technologies that they previously had no intention to institutionalize (Molla 2009b). This requires of governments particular care when drafting policy that will have economic and social impact. Moreover, it requires a complex set of commitments: leadership by example (i.e. the ability to fulfil targets and standards); the support to R&D activities; the creation of incentives to compliance; the provision of responsive energy and telecommunications infrastructure; and the design of education programmes to make organizations aware of the potential benefits of Green IT (Kim et al 2009).

In the western world examples of regulators' Green IT interventions are abundant. For instance, at regional level the European Union has issued the Waste

Electrical and Electronic Equipment Directive (WEEE), which covers how EEE are sold, purchased and disposed (European Parliament 2012). The directive requires manufacturers to take back EEE after their life cycle, emphasizing their responsibility over the disposal of electronic waste. Member countries are expected to enforce it with the help of national agencies.

In the United States, the Environmental Protection Agency (USEPA) has in place an Electronic Product Environmental Assessment Tool (EPEAT). The EPEAT is an online tool that enables institutions to compare the environmental features of IT equipment, thus promoting the purchase of more environmentally friendly products (Omelchuck et al., 2006). A more recent example is offered by the United Kingdom's Department of Energy and Climate and the introduction of mandatory reporting of greenhouse gas emissions by quoted organizations (Department for Environment, Food and Rural Affairs 2013).

In developing countries the impact of Green IT regulatory intervention is comparatively less expressive. Petzer, McGibbon and Brown (2011 alert for the failure of organizations in African countries to adhere to environmental sustainability measures, which they attribute to the prevalence of economic interest over concerns with environmental sustainability. Furthermore, when organizations adopt Green IT the driving force is the pursuit of a better public image and the impact of regulators' policy is negligible as there is no form of penalty or sanction to punish offender. In this context, compliance is frequently a matter of choice. An instantiation of this stems from a recent enquiry into Kenyan personnel views of Green IT that revealed low levels of Green IT awareness (Wabwoba et al. 2013). Participants showed some

knowledge of areas such as disposal of IT equipment and cost reduction for data centres. However, aspects such as the procurement of environmentally friendly equipment or the use of ICT to minimize business practice emissions were not significant areas of concern. In this specific case several possible explanations for this limited awareness are advanced: the high cost of Green IT implementation, insufficient skills and technical understanding of Green IT, and the existence of poor regulations to enforce adoption.

3. Methods

The research was carried out in the context of government regulators operating in Nigeria, within the strategic remit of Green IT, as outlined in Table 1.

INSERT TABLE 1 HERE

In order to understand what is signified in Green IT institutional structures and practices, it was essential to access manifestations of strategies used by regulators to legitimate Green IT policy. This endeavour follows similar studies of the ideational aspects of institutionalization, in particular the focus on institutional vocabularies, and the ways in which organizational actors invoke specific logics of professionalism (Suddaby and Greenwood 2005). A series of semi-structured interviews were conducted with the full set of senior executive managers affiliated with the Nigerian governamental regulators that share Green IT as a strategic remit (see Table 1). The interviews took place between May and September 2014 and focused on: institutional attitudes towards Green IT; perceived role of Green IT policy; and perceived

implementation barriers. An interview protocol was created to guide the semi-structured interviews, where open-ended and probing questions were combined in order to elicit experiences and prompt senior executive managers for explanations and detail. Table 2 offers a summary of the key themes contained in the interview protocol, combined with illustrative questions and pointers to the literature that informed their design.

Interviews lasted on average 90 minutes. They were audio recorded and subsequently fully transcribed. Notes taken during interviews were used as probes to draw out participants' meanings in their own terms. The process of data analysis followed a qualitative, inductive approach. More specifically, we applied the thematic analysis technique (Braun and Clarke 2006). The first step taken was the transcription of all interviews that had been conducted. Subsequently the research team read through the data to try and gain a first understanding of what participants were saying, making notes of interesting points found. This has helped to gain a first understanding of participants' lived experiences and conceptions. The next step involved generating codes that captured those experiences and conceptions. Codes were then grouped into themes, which were iteratively revised to ensure consistency and avoid repetition (see Appendix 1 for an overview of the coding structure). What follows next is a detailed presentation of the themes inductively extracted.

INSERT TABLE 2 HERE

4. Findings

4.1 Reactive policy development

A dominant perception among regulators was that the development of Green IT policy in Nigeria reflects a response to episodic pressure and is typically subordinated to economic development policy, which the government perceives to be a priority. A reported frequent source of pressure is the existence of recurrent environmental hazards resulting from the disposal of e-waste:

> 'The effects of poor e-waste disposal were starting to become evident or noticeable. The country was also becoming a dumping ground of e-waste from developed countries (N3:3).

This contrasts with Green IT policy areas that do not attract a similar level of governmental attention, such as the use of energy efficient systems and software to help control energy consumption:

> So far the government has not seen the need to address energy efficient systems. I guess it is because they really have had no drastic negative effect or should I say influence compared to e-waste (N2:1).

An explanation frequently advanced for a diminished interest in Green IT policy pertains to the identification of economic development as the top priority of the government's actions. Environmental sustainability issues are not perceived to contribute highly to the country's developmental aspirations. The country's greatest

objective as outlined in the Vision 2020 policy document is placing Nigeria amongst the world's top twenty economies by the year 2020:

> I guess in the scale of things, economic development is more important than sustainable development as far as policy makers are concerned (N1:4).

This stance suggests linear thinking in policy formulation, particularly as in a systemic model of sustainable development, environmental and economic policy objectives are understood to be complementary, and ideed part and parcel of the sustainability process.

4.2 Regulatory strategies and mechanisms

Despite being generally perceived to play a secondary role in the country's development, some Green IT policy areas are growingly concentrating the regulators' efforts. At the forefront of regulators' actions is e-waste control. E-waste refers to obsolete electronic equipment such as monitors, printers, TVs, phones that have been discarded when nearing or reaching their end-of-life. E-waste is perceived as a serious problem, particularly when developed countries export their obsolete and malfunctioning electronic equipment:

> They [developed countries] have stricter environmental laws over there and instead of taking care of their own waste, they were sending them to developing countries in the guise of helping us bridge the digital divide (N5:1).

The situation was getting worse as the level of e-waste in Nigeria was rising especially due to the lack of recycling facilities to handle it. Major disposals were done by reckless dumping or burning the waste, which posed serious environmental dangers to the country:

> In our cities and communities you see dead computers that are no longer in use and they are just dumped in public waste collection or within the environment without regard for its hazardous effects (N4:2).

In order to tackle these problems, a national environmental electrical/electronic equipments (EEE) policy was developed by NESREA based on a life cycle approach and driven by five main goals: reduce, repair, reuse, recycle and recover. Banning the imports of used EEE was not recommended as it would be counterproductive and could potentially encourage illegal activity. Hence a guide for importers was developed to govern the imports of used EEE into the country. International cooperation agreements were also set in place with agencies devoted to environmental compliance and enforcement for the speedily communication of information and alerts:

> We have those in the ports like in Belgium, where the authorities inform us when they notice containers that may contain e-waste. We have worked with the Interpol who usually send information to their national bureau in Nigeria who then contact us. We have also worked with the UK environmental agency and many others (N3:1).

At national level, a harmful waste Act was enforced to prevent the deposition or dumping of e-waste on bodies of land and water. Extended user responsibility strategies are also being considered to reduce the environmental and societal impacts of EEE. The importers of used EEE are mandated to register with NESREA and are then issued a certificate. Certificates are checked at the ports to ensure only legally registered importers are allowed to bring in controlled EEE equipment:

> It is not like we still do not inspect it, we still do but then at least we know these are valid importers and so every other importer is turned back who do not possess our certificate (N6:2).

The issuance of certificates was perceived to have increased the efficiency of the process and enhanced the regulatory process. In addition, the customs service web portal containing a database of imports into the country is also available for consultation by the regulators and is used to make further decisions on potential inspections:

> From our office we can access the Nigeria Integrated Customs Information System portal. If we find anything of interest we contact our offices at the port, those in Lagos or Portharcourt depending on the area they are bringing such goods. They then go the port and follow up on inspections (N3:1).

The use of the portal by the regulators instantiates the growing attempt to combine electronic government initiatives with environmental sustainability. The regulators endorse the governments' strategy of encouraging citizens and agencies alike to access government services available online, therefore reducing the need to travel and physically visiting offices:

> There is an e-government framework and application which is still under development but is aimed at giving access to people from whatever location they are. People will no longer have to travel or go to government offices for whatever need like company registration etc. (N7:2).

Finally, the incorporation of renewable energy sources into the core business strategies of governmental agencies is another green initiative enabler promoted by the regulators, in collaboration with international commercial partners. An example frequently mentioned is the partnership established with a China-based global information and communications technology solutions provider, which leverages the latest energy-saving and transmission technologies to offer eco-friendly power supply for schools and government agencies:

> There is a renewable energy policy that brought about solar energy and wind energy. We have implemented the solar in our head office here in Abuja and some universities and are still doing more research on how to develop it further (N2:2).

4.3 Awareness-raising strategies

The participants in the study held a consensual view concerning the role played by public awareness campaigns in the shaping of an appropriate regulatory environment. Significant time and effort were thus perceived to be put into designing and implementing measures to promote awareness about Green IT both for the general pubic and parties whose actions are potentially damaging to the environment. Considering that tackling e-waste was previously identified as a priority by the regulators, it is not surprising that importers of EEE and scavengers are amongst the preferential targets for training and awareness campaigns:

> In 2010 we had training for importers of used EEE into the country. In that training they were taught the health effects and environmental impacts of e-waste. We have had flyers, TV and radio programs also. Officers in the states also go and educate people in their various states (N1:1).

Awareness campaigns were also in place to sensitize ICT firms, particularly services providers, as they are amongst the top users of IT equipment:

> We have been talking about using renewable forms of energy and technology that impact less on the environment. There have been seminars both locally and even at the African level to educate these firms about the importance of sustainability. We continue to promote eco-friendly technology in ICT (N3:3).

Although there are no impact indicators readily available to demonstrate the effectiveness of these measures, anedoctal evidence quoted by participants suggests instances of behavioural change have been observed. A fundamental enabler of change has been the crowdsourcing of sustainable ideas, where regulators provide funding to entrepreneurial ideas that apply IT to environmental management:

> Incentives are given to operators and also innovation in ICT. We encourage individuals, research institutes to come up with ideas that are innovative mainly geared towards sustainable forms of energy that could be applied in ICT (N2:3).

An example of a recently funded R&D project was an idea submitted by a Nigerian Higher Education Institution committed to using solar energy to run the ICT equipment at NITDA.

4.4 Financial and infrastructural limitations

Insufficient resources and financial restrictions were identified by participants as critical barriers to the development of Green IT. The use of software that could encourage sustainable behaviour in organizations was reportedly non-existent due to the lack of available funds or incentives.

Well you know developing such software tends to cost a lot. So telling organisations to have this in place without funds or incentives to assist is a problem (N6:1).

Similarly, encouraging organizations to properly dispose of their e-waste was perceived to be hindered both by insufficient funds and the lack of proper collection and recycling facilities:

The main problem is people will always look for cheaper alternatives. So resources, money come to play when you think of e-waste and that is where the government needs to come in to provide more funding to properly dispose of these waste as doing it on their own might be very expensive (N4:3).

However, infrastructural problems span beyond irresponsive collection and recycling facilities. The regulators share a common concern over the insufficiencies of Nigeria's power supply network. Recurrent energetic failures and the prevalence of self-production systems undermine regulators' systematic efforts in sensitising users for sustainable behaviour:

Another problem is the poor power supply. How can you tell people to control what you are not even supplying enough to them? It's more like they want to utilise it when it's available rather than save it (N5:1).

4.5 Coordination of regulators

The existence of difficulties in achieving coordination amongst regulators was another major limitation frequently reported. Several reasons were advanced as the root causes of this poor coordination. One of them was the lack of clear responsibility or authority given to each regulator, aggravated by poor policy alignment between the regulators, and by confusing lines of accountability as to which regulator was to be ultimately held responsible for which dimension of Green IT policy. Areas of duplication of authority were perceived to be commonplace, making it difficult to who is to be held responsible for certain areas:

> Everybody wants to create a path where they can make money because there is supposed to be just one regulator for most of these issues. Then you discover you are no longer sure who is to do certain activities. But sometimes we meet and discuss and try to better settle things (N2:4).

Such overlap is caused by conflicting high level mandates attributed by different Ministries, Departments and Agencies that control specific regulators. In the Nigerian context, NITDA and NCC respond to the Federal Ministry of Communication Technology; and NESREA is accountable to the Federal Ministry of Environment.

Another reason advanced by participants for poor coordination was the reported inability to work together effectively. This difficulty was attributed to regulators' adoption of different sets of international standards, which would inevitably lead to conflicts in different areas of environmental sustainability regulation:

Most times we had to work with NCC and NITDA especially in areas of monitoring and our staff bring reports of clashes. We have situations where we close down masts and NCC goes and reopen them. This is one example of how difficult it is to integrate departments and agencies here, especially when they are not under the same ministry (N6:1).

In the example above, transmission masts were shut down by one of the regulators because they were found not to respect the minimum distance from residential areas and could potentially emit harmful radiation. Another regulator with overlapping competence decided otherwise and considered that appropriate distances were respected, based on the international standards they followed:

If we adapt the American standard and they now decide to adapt the European standard and they are not perfectly in alignment, there will be conflict on which supersedes which (N4:3).

This misalignment and miscommunication appeared to a major problem between regulators as each of them appeared to be working independently rather than in close articulation to address common issues. The environmentally oriented regulator was concerned strictly about environmental impacts, while the ICT-oriented regulators were more focused on providing access to technology and infrastructure. What transpires from this latent conflict is the need to harmonize rules and procedures so that regulators' decisions do not clash and contradict each other. At a deeper level, difficulties of this kind may be a symptom of an even greater problem, which is the ambiguity concerning which regulator is truly accountable for Green IT, since it

intersects areas traditionally addressed by several agencies who do not hold a record of previous collaboration:

> If we are driving policies on ICT, it will just be on ICT and not at the national level because we do not have jurisdiction over the power sector for instance. But the ministry of environment is set on providing a better environment for Nigerians and that cuts across the power sector and the ICT industry. So the ministry of environment and NESREA should be the driver in formulation of national policies and then all other sectors will develop a clue from that or begin to design their policies to meet the law (N1:3).

This particular participant felt their agency played a major role in defining standards for ICT industry, although its capacity was somehow diminished when it came to drive issues related to environmental sustainability. However, participants in the parallel agency that regulates IT development put forward a contrary conception, advocating that the Ministry they represent - the Federal Ministry of Communication Technology – should be the driver of Green IT policy:

> The ministry of communication technology should be in charge of driving Green IT, after all we are the policy developers of what IT should be. I believe we should be in charge of driving this, and then NESREA should be in charge of promoting awareness on what the health and environmental effects of e-waste and other ICT related effects are then NCC and others will follow (N2:4).

The existence of these conflicting views suggests there is no clear definition of responsibility towards Green IT from the regulators representing both the environmental sustainability and the ICT development spheres. It stands as a critical barrier to the alignment of policy and to the effective promotion of Green IT in the country.

5. Discussion and conclusion

Nigerian regulators express the view that the country's ICT policy does not fully address the environmental dimension, the major exception being the country's regulations on e-waste. This is not uncommon in the context of developing nations, which tend to prioritize economic development over the environmental sustainability agenda (Desai 1998; Gray 2003; Lo et al. 2006; OECD 2012). The OECD (2012) report on green growth and developing countries, in particular, exposes a continuing situation where developing countries are slower in enforcing environmental policies as 'policy ideas and technologies are neither easily accessible nor entirely relevant to their national developmental needs'. The situation portrayed in the OECD (2012) report matches the dominant concerns emerging from the thematic analysis conducted on Nigerian regulators' perceptions: the need to develop the Nigerian economy is framed as a priority.

In particular, there was a consensual view that the country's efforts should be channelled towards attaining the Nigeria 2020 development plan, which aims at placing the country amongst the top twenty economies by the year 2020. This reflects

a situation conceptualized by Toteng (2001), where authorities who possess the power to influence environmental regulation believe there is a conflict between economic development and sustainable development, making it extremely difficult to establish and enforce environmental regulations. As identified in our analysis, Nigerian ICT regulators found economic growth a more pressing need than the effective regulation of IT sustainability. The environmental regulators on the other hand appeared to be more concerned about environmental sustainability than economic growth. The differences in such views may be due to where each organization feels their main jurisdiction lies and what expectations the government has from them. The literature highlights examples of such situations, where conflicting sector interests and an overly protective administrative culture emerge as an obstacle to environmental policy integration (Håkansson and Asplund 2002; Nilsson and Persson 2003; Nilsson 2005), The absence of cross-sector regulations and the poor articulation of environmental goals by intervening political agents often leads to compromised environmental requirements (Fudge and Rowe 2001; Jordan and Lenschow 2010).

In order to mitigate these obstacles, a clearer alignment of expectations and a clarification of remits of action are required. This clarification can take place via the establishment of integrative administrative structures, conciliatory operative instruments that make up for the absence of strong, consistent political will (Persson 2007; Jordan and Lenschow 2010), and a strong legislative system that counters fragmentation both in local actors' knowledge and understanding, and in formal institutions' policy (Bass and Dalal-Clayton 2012).

5.1 E-waste control

A shared concern of the Nigerian regulators was the control of e-waste in the country, namely through a closer scrutiny of imported used electronic equipment originating in developed countries, which frequently happened to be non-functional or nearing the end of their life cycle. The problem with high import rates of used EEE into developing countries is highlighted in the Basel Convention (2011) report, where it is acknowledged that 30 per cent of EEE imported is already waste that will ultimately be disposed of in improper conditions. According to Houghton (2009) the main targets of this practice are India, China, Nigeria and Ghana. The consequences for the environment are manifold and include the illegal dismantling and dumping of EEE waste, or the open burning of equipment, which produces high levels of CO_2.

The high rate of e-waste in Nigeria – totalling 1,100,000 tones per year (Ogungbuyi et al. 2012) – explains the regulators' committment to controling the imports of EEE, and regulating the refurbishment and recycling of EEE. In a study that compares Green IT diffusion at international level, Mola et al. (2009) propose that mandatory regulations and policies set in place by national governments and regulators will enhance and induce compliance to policy. In the case of Nigeria, the mandatory compliance enforced by the regulators on importers of used EEE through ensuring only those registered are permitted to bring in used EEE was noted to have yielded success, since the last illegal import into the country was found to be carried out in January 2013. Similarly, the Nigerian regulators highlighted the application of the Extended Producer Responsibility policy that places the responsibility for a product's end-of-life environmental impacts on its producers.

However, Nigerian regulators remain concerned with the limited awareness individuals and organizations have of Green IT. This barrier is also identified by Wabwoba et al. (2013) in their study of barriers to Green IT in Kenya, where insufficient skills were particularly constraining. In Nigeria, the establishment of international partnerships was found to address that specific gap, by providing 'technical and technological assistance, encouraging governments to share their experiences, exchange knowledge and help to build capacity in green economy policy design and implementation' (UNDESA 2013). This experience reinforces the argument that international partnerships can help developing countries better control the imports of e-waste (Houghton 2009), more specifically through sharing information between international partners concerning suspected illegal e-waste imports.

5.2 Addressing regulation challenges

In developing countries, less funds are typically allocated to issues pertaining to environmental sustainability (Puppim De Oliveira 2002; Gray 2003). A common trend in African countries is the allocation of greater shares of public funding to 'economic and financial ministries', as opposed to agencies that directly deal with environmental affairs (Gray 2003). Similar financial constraints have been reported by the Nigerian regulators in this study (e.g. insufficient governmental incentives to promote sustainable IT behaviours in organizations), which are inimical to effective environmental regulation. This scenario substantiates the idea that effective regulation requires the commitment of continuing streams of funding, but in developing

countries, 'unfortunately, sufficient resources are seldom allocated to the enforcement of environmental regulations' (Lo et al. 2006).

The limited trustworthiness offered by key energy infrastructure is another barrier to environmental regulation. In Nigeria, this ranges from problems related to power supply (Aliyu et al. 2013; Andersen and Dalgaard 2013) to the absence of proper collection and recycling systems, despite the existence of policy that punishes the dumping of harmful waste of e-waste on land and other bodies.

Regulation challenges were also found at inter-organizational level, which is not uncommon in developing countries (Puppim de Oliveira 2002). Quality regulation should be flexible, rigorous on enforcement, reflexive and supported by adequate resources (Ribeiro and Kruglianskas 2014). However, Nigerian regulators were worried about what they perceived to be a lack of clarity concerning who should be responsible and who should be the driver of Green IT policy. This phenomenon is not unusual in public sector agencies and has been found to affect the flow of information and cooperation due to differences in culture, visions and values (Yang and Maxwell 2011). The result is each regulator being strongly attached to their world-view and at times pursuing their self-interest, competences and resources (Jordan and Lenschow 2010), which stands in the way of broad consensus on fundamental environmental issues (Armistead and Pettigrew 2008; Lidskog and Elander 2010). The situation resembles what Vasconcelos et al. (2012) typify as a social arena conflict. Each regulatory body claims a part to play in the development of Green IT policy, so each represents their social world-view in that arena (Green IT policy development). Each social world in the arena represents different views of what needs to be done and how

it should be done, leading to conflicts in the arena and each party choosing to go their own way with little or no negotiation.

Overcoming conflicts in the arena requires a closer alignment of regulatory activities and an abandonment of a governmental silo mentality (Russel and Jordan 2009). Regulation and promotion of Green IT in developing countries such as Nigeria could be strongly improved by stronger collaboration between the regulators involved. Green IT does not lie solely on the shoulders of the ICT regulators or on environmental regulators alone. Considering that it cuts across various substantive sectors, a strong synergy is needed amongst these regulators to efficiently and effectively promote and regulate Green IT. This argument echoes Puppim de Oliveira's (2002) view that successfully implementing environmental policies in developing countries develops through decentralizing environmental policy implementation to economic development-oriented agencies. The process leading to this requires negotiation and consensus building (Innes 2004), in a genuine attempt to develop inter-organizational coordination (Alexander 1995), joint learning, common strategies, and appropriate monitoring and reporting mechanisms. We propose that in Nigeria the progressive integration of environmental policy into the agenda of economic development-oriented regulators requires that: the Federal Ministry of Communication Technology and the Federal Ministry of Environment ensure areas where duplication of authority may arise are avoided; a joint Green IT regulatory effort is developed with a clearly defined description each agencies' specific roles; each agency contributes to promoting Green IT based on their unique capacities and resources.

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Table 1: Nigerian regulators who share Green IT as a key remit.

Regulator	Strategic goal
National Information Technology Development Agency (NITDA)	Responsible for creating and regulating national IT policies and ensuring the use of IT promotes economic growth
National Environmental Standards and Regulations Enforcement Agency (NESREA)	Responsible for regulating environmental issues in all sectors. Monitors environmental sustainability and issues cross-sectorial policy and regulations
Nigerian Communications Commission (NCC)	Responsible for creating policy and regulations in the telecommunications and ICT sector

Table 2: Key topics covered by the interview protocol

Themes	Illustrative questions	Literature that informed interview protocol design
Green IT policy and factors that promote policy setting	Can you give us a brief overview of existing Green IT policy? How are different areas of IT and sustainability (e.g. energy efficient systems, e-waste) considered when designing policy?	Brooks et al. (2012); Dedrick (2010); Gholami et al. (2013); Tushi et al. (2014); Molla (2009a); Sarker and Young (2009).
Policy regulation and monitoring	What reporting mechanisms are employed to ensure compliance with existent policy? What measures are in place to control IT imports?	Gartner (2007); Gholami et al. (2013); Molla (2009b); Molla and Cooper (2010); Petzer et al. (2011); Sarker and Young (2009; Watson et al. (2008); Watson et al. (2010).

Themes	Illustrative questions	Literature that informed interview protocol design
Barriers to/ limitations of Green IT policy	How would you describe the collaboration and flow of information between regulatory agencies?	Brooks et al. (2012); Dedrick (2010); Gholami et al. (2013); Houghton (2009); Molla (2009b); Petzer et al. (2011);
	What in your view are the major barriers to Green IT?	Sarker and Young (2009); Wabwoba et al. (2013); Watson et al. (2008).

Appendix 1: Overview of the coding structure

Major themes	Sub-themes	Initial themes	Illustrative quotations
Reactive policy development	Environmental hazards; Governmental priorities.	Economic development; Negative environmental impacts; Scale of importance; Government focus	'ICT policy has been focused on economic development. Policy is focused on trying to see how IT policy can be used to support development, rather than the sustainable use of IT itself (N1:1)'.
Regulatory strategies and mechanisms	E-waste control; Renewable energies; E-government initiatives.	E-waste; E-government framework; Renewable energy resources; Certification; Mandatory compliance; Monitoring; Inspection checks; Collaboration.	'Before any ICT equipment is brought in we carry out approval testing. We ask for declaration of conformity to certain international approved standards. You must conform that those equipment are within the tolerable radiation levels (N2:3)'. "There is a renewable

			energy policy that brought about solar energy and wind using ICT… we have implemented the solar in our head office here in Abuja and some universities and are still doing more research on how to develop it further (N4:2)".
Awareness-raising strategies	Training and public information; Ideas crowdsourcing; International partnerships.	Workshops and seminars; TV and radio ads; Incentives to operators; Incentives to innovation; International partnerships.	'We have supported young people that develop ideas that could encourage sustainability for ICT development and we continue to promote eco-friendly ICT (N5:2)'.
Financial and infrastructural limitations	Financial limitations; Poor infrastructure.	Insufficient funds; Limited resources; Poor power supply; Absence of recycling facilities.	'Right now because we do not have any collection or recycling measures, the scavengers do the collection. We are presently

trying to develop a collection centre and the Bureau of Public Procurement has advertised for interest reputable firms (N3:1)'.

| Coordination of regulators | Unclear lines of accountability; Multiple authority; Poor alignment. | Poor Information flow; Bureaucratic governance and corruption; Poor collaboration of MDAs; Authority clash; Limited control. | 'Policies and regulations of agencies need to be harmonised for regulation to be more effective and that is something the government needs to look into, especially the house of assembly. You know there are different standards when ICT is deployed so they need to harmonise the laws (N2:3)'. |