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# The impact of auditing on green information and communi- cation technologies

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## Abstract

*The main purpose of this paper is to identify how auditors can contribute to supporting the protection of natural environment, without this being subject to their engagement. The interest in the topic was determined, on the one hand, by the infiltration of the information and communication technologies (ICT) in the auditors' work and, on the other hand, by the significant increase of the concerns for environmental protection. The intersection of the two areas has led to the concept of green ICT auditing, approached by the present study. Within it, we argued the importance of establishing positive connections between auditing, environment and ICT for the society. We provided a brief presentation of the green ICT concept, as a result of the selection and study of the most relevant opinions from the specific literature. Next, in the most important part of the paper, we presented in detail how auditing can contribute to augmenting the favourable influences of green ICT on the environment, the latter being regarded both as a subject and as an object of auditing. Based on the information collected while performing the study, we concluded that auditors can have a significant role in decreasing the influence of ICT on the environment, but only if their endeavours are supported and sustained by the companies subject to audit engagements.*

**Keywords:** auditing, environment, green ICT, ecosystem

**JEL Classification:** M42, Q56, F64, L86

## 1. Introduction

The economic evolution is significantly influenced by the innovation of the information and communication technology (ICT). These led to major form and substance changes in the activity of companies from different fields, which further on produced changes in the audit field. Auditors needed to continuously adapt to changes, called forth by the assimilation of the new technologies in organizations (Homocianu, Airinei and Dumitriu, 2014; Hurbean et al., 2013), as well as to focus on strictly defined fields. On the one hand, the increased importance attached to the environment created strong links between the environmental protection and the ICT development and use.

Murugesan (2010) considers that they can contribute to the natural equilibrium by *“optimizing the work flows within organizations, in order to minimize their impact on the environment, increasing the energetic efficiency of the employed equipment and systems, analyzing, modelling and simulating the environmental impact of various natural phenomena or social events, using applications which deliver information on the CO<sub>2</sub> emissions, auditing and reporting the energy consumption and savings, delivering management systems for environmental knowledge, decision support systems and management ontology”*.

The increased awareness of environmental issues, the development of ICT and the identification of the potential of the latter in the context of the eco-system protection gave birth to the green ICT concept (G-ICT). According to the most recent definition, the green information and communication technologies are “the study and practice of the design, production, use and disposal of computers, servers and associated subsystems, like monitors, printers, storage devices, as well as the development of efficient and effective communication networks and systems, with a minimum or zero negative environmental impact. More, they aim at reaching economic viability and improving the system performance and usefulness, while observing the social and ethical responsibilities” (Murugesan, 2008).

The stronger environmental concerns led to the introduction of the G-ICT concept into various fields, auditing included, especially through the *environmental audit*, but also through other auditing forms. For example, with regard to the *information system (IS) audit*, one of the benefits mentioned by Năstase and

Caia (2015) suggests the connection between G-ICT and audit, though the authors do not refer directly to this field. Out of the benefits mentioned by the authors, we consider the following with regard to the topic of the present paper: drafting the plan for unpredicted situations and disaster recovery, assessing the effectiveness and efficiency of the resource use, as well as managing information and development systems (Năstase and Caia, 2015).

The environment issue is also mentioned in the context of *financial audit*. The International Auditing Practices Committee (IAPC) of the International Federation of Accountants issued in 1998 the International Auditing Practice Statement (IAPS) 1010 “The Consideration of Environmental Matters in the Audit of Financial Statements”, in order to support auditors, by providing recommendations with regard to the application of the international standards, where environmental issues are significant for the financial statements of the entity (Ienciu et al., 2012). In this case, the environmental issues can be approached both by internal and by external auditors. Internal auditors can be interested in the controls required for the minimization of the negative impact on the environment, in order to be assured that the environment-related operations are efficient and the environment-related decisions are documented. External auditors are interested in the impact of the environmental matters on the information disclosed in the financial statements, through the observance of the regulations in force, as well as through the value of the assets, equity and liabilities, related with activities which are either influenced by the environment, or exert influence on the environment.

Starting from the above described concepts and approaches, the objective of the paper is to analyze the manner in which audit can be used in supporting the expansion of G-ICT from two distinct standpoints: as an object and as a subject of auditing.

## 2. Research methodology

The present paper is part of a more extensive research on the influence of the ICT use on the environment, performed in the last years and whose results have been communicated in different conferences and articles in

specialized journals, however without connecting it so far with the field of auditing.

The objectives of the study required the preparation of a qualitative analysis, meant to highlight the changes required in audit for responding to the environment protection regulations, as well as to the influence on the environment of the ICT use in auditing. The auditing and the G-ICT specific literature, as well as the literature associated to the intersection of the fields (ICT auditing and environmental auditing) was reviewed and analyzed. The personal contribution consists in the provision of the own opinion on the connection between environment, auditing and the ICT, as well as on the manner in which the relationship between the three can be managed, so that auditing supports the G-ICT development.

From the standpoint of the applied methodology, the research is constructive, starting with the description of the ICT significance, their role in the environment protection and the premises that led to the strengthening of the G-ICT practices. We continued with the study of the manner in which auditing can influence the stance of the organisations over environmental protection, both by means of the environmental audit, and by other means, which do not address directly this topic. We emphasized the importance of supporting, by stance, the assurance

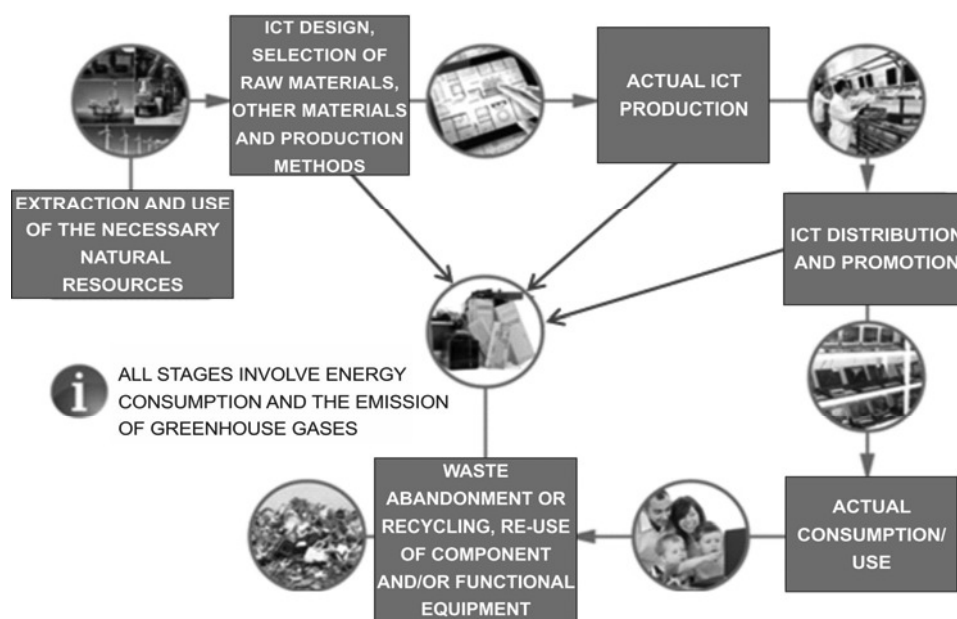
of a natural equilibrium for the society in the auditing activity, irrespective of its nature.

The paper is structured in five sections. The first one introduces the relationship between auditing, environment and the ICT. The second one presents the objectives of the study and the research methodology we selected, in order to reach the objectives. The third section describes the G-ICT conceptual framework, as well as the changes required by their adoption. Further on, the fourth section presents concretely the manner in which auditing can influence the relationship between ICT and the environment, while the last section summarizes the conclusions of the study.

### 3. G-ICT - conceptual framework and technological changes

The ICT sector responded in a positive manner to the environmental protection concerns, by developing innovations with minimum negative impact and performing substantial investments in environmental monitoring. These build the G-ICT concept and consist in preoccupations associated to all stages in the life cycle of equipment and applications, as shown by Figure 1:

Figure 1. ICT life cycle and its influence on the environment (Radu, 2013)



Source: Radu, 2013

The first stage in which the environmental protection issue is considered is the extraction of natural resources, necessary for producing the hardware. The extraction should be performed with environmental non-invasive means, while the raw materials and other materials should be mainly recyclable and biodegradable. In the same line, the production method which responds best to the environmental protection standards should be selected.

The designed and manufactured products should have no, or at the most a minimum negative impact on the environment. Not only hazardous metals, like lead, mercury or cadmium are currently used, but also significant amounts of water (the ICT field is seen as one of the six greatest water consuming sectors in the semi-conductors industry) and energy from polluting sources are consumed. More, both the production process, and the use and disposal of the equipment generate considerable CO<sub>2</sub> emissions. Consumers of ICT products should have an environmentally responsible behaviour. In this context, there are several rules that should be applied within organizations, as long as such equipment is in use, but also at the end of its service life. In this last stage, components should be re-used, if possible.

Environmental concerns appear not only with regard to specific ICT equipment. A further preoccupation of the sector is the development of applications with minimum negative impact on the environment, known as *green software engineering*. Green software engineering implies that software products are designed and produced so that the negative and positive effects of their use on the sustainable development, along the entire service life, are continuously assessed, documented and employed for the optimization of the product (Dick and Naumann, 2010). Naumann et al. (2011) created an application development model with these features, aiming to support developers, administrators and users in creating, maintaining and using applications, with a minimum negative impact on the environment. Within a further model, proposed by Shenoy and Earatta (2011), several suggestions are included, which should be followed in every stage of an application's life cycle, in order to decrease the CO<sub>2</sub> emissions. The component controlling these aspects within applications is the algorithm efficiency, which manages the resources used by different applications. Out of pragmatic, mostly financial reasons, the

development of highly efficient algorithms from the standpoint of the resource consumption is sometimes abandoned, in favour of the equipment supplementation.

G-ICT can also contribute to environment protection by means of additional measures, referring to the manner in which the economic activity of the companies is performed, such as:

- The coordination, re-engineering and optimization of the supply chain, production activities and organizational flows, with a view to the minimization of the impact on the environment;
- The efficiency increase of business operations, buildings and other energy systems;
- The analysis, modelling and simulation of the environmental impact, in order to identify the most efficient business processes from the standpoint of the relationships with the environment;
- The provision of platforms for eco-management and the management of the CO<sub>2</sub> emissions;
- The auditing and reporting of energy consumption and savings;
- The use of management systems for environment knowledge, the use of decision support systems and the development of environmental ontology;
- The integration and aggregation of data from different environmental monitoring networks (Murugesan, 2010).

Based on the above presented issues, we observe that the technological innovation in the ICT field is currently oriented towards stimulating environmental friendly characteristics, by developing devices and applications that allow environmental monitoring and the identification of solutions to the existent problems, generated by humans or natural phenomena. Due to the evolution of the field, it is possible to record and store a huge amount of historical data, with a wide geographical spread (*big data*), to perform calculations based on complex algorithms which allow the modelling of information with regard to the human eco-system, to monitor the environmental changes by means of the GIS systems, to exchange information in real time between interested people and organizations, to connect physical equipment (*the Internet of things*) which, integrated in a larger system, provide control, monitoring and communication opportunities.

An important process of G-ICT is the migration of applications in *cloud computing*, with significant

advantages for the environment protection. Cloud computing is a new model, which integrates existent technologies and models, in order to optimize the use of physical and logical resources. Its increased popularity is due to the benefits it provides for organizations, motivated to move their activity in the cloud, within which *the environmental protection* plays an important role (Nandgaonkar and Raud, 2014; Mohamed and Pillutla, 2014; Kavitha, 2014; Mansuri et al., 2014; Chou, 2015). The environmental protection refers to the development and application of better strategies for the decrease of the energy consumption, the decrease of the required amount of equipment and, implicitly, of the resources amount needed in the equipment production, as well as the decrease of the waste amount (Linthicum, 2009). More, from the standpoint of the consumers, service providers can be selected based on the employed energy sources and the pro-environment initiatives. However, the technological development is accompanied by specific risks and requires the design and implementation of controls, meant to maintain the security of the information which is managed and stored by means of the cloud computing technology, while the audit needs to adapt to the security requirements and the specific features of this environment (Bendovschi and Ionescu, 2015).

In this section we presented the main forms and technologies through which the G-ICT concept influences the activity of the organisations, as well as the changes that were generated in the production and use of hardware and software in its support. Further on, we shall describe the relationship of G-ICT with the auditing activity.

## 4. G-ICT and its relationship with auditing

It has currently become at least unlikely, if not impossible, to perform an audit engagement without employing ICT either as an instrument, or as the object of the audit, or both. In the first case, they spread the ICT influence on the environment and can contribute to its protection by adopting G-ICT. In the other two cases, the auditor can assess the influence of these technologies on the environment. This aspect is also emphasized by the previous studies, which considered mainly the influence of the CO<sub>2</sub> emissions. The authors analyzed both the possibility

of employing ICT for recording and auditing the CO<sub>2</sub> emissions, in order to analyze their impact on the environment (Mouchet, 2014), and the emissions of ICT (Moyer and Hughes, 2012; Raju, 2013). The results emphasize both the negative, and the positive effects on the eco-system. The research can be extended to the consumption of non-renewable resources in the production and use of ICT, the electronic waste (e-waste), the global warming and other aspects with a negative impact on the environment.

In the long term, the solution for the environment is to stimulate the ICT development with minimum negative influences on the eco-system, respectively the previously mentioned G-ICT. An additional argument in this case is given by the spectacular increase of the information amount in the business environment, which made the existent collecting, processing and storing methods insufficient. According to IBM studies, 2.5 quintillion bytes of data are created every day - the amount of information is so large, that 90% of the currently existing data were created in the last two years (Zikopoulos et al., 2014). Under these circumstances, auditing becomes increasingly more difficult and consumes more and more resources, mainly of ICT nature. We shall further on present the manner in which auditors can participate in the environmental protection, while performing audit engagements.

### 4.1. The environmental audit

The *environmental audit* was born as a reaction to the environmental damages. The environmental audit is a management tool which consists in the systematic, documented, periodical and objective assessment of the environmentally related organisation performance, management system and processes, meant to: (1) facilitate the management control of the practices with a possible impact on the environment; and (2) evaluate the conformity with the company policy (CEC, 1993). The application areas can be classified, in respect of ICT, in two main categories: specific to ICT producers and specific to ICT users. **Table 1** illustrates, for each category, the aspects through which these can get involved in the eco-system protection:

**Table 1. Environment protection for ICT producers and users**

ICT producers	ICT users
<ul style="list-style-type: none"> <li>• The efficient management of raw and other materials, savings and the identification of less environmentally harmful solutions;</li> <li>• The assessment, control and reduction of noise in the production process;</li> <li>• The transport of raw and other materials from the supplier and the delivery of finished products;</li> <li>• The communication of real information with regard to the effects of the finished products on the environment (energy consumption, pollution, estimated service life etc.).</li> </ul>	<ul style="list-style-type: none"> <li>• The energy management and energy savings;</li> <li>• The generated waste and its efficient management;</li> <li>• The air quality control by means of pollution decrease measures;</li> <li>• The limitation of travelling, by using alternative communication methods;</li> <li>• The environmental concerns of the management, the organization of/participation in training programs focused on the environment;</li> <li>• The publication of real and correct information with regard to the environment.</li> </ul>

Source: Author's projection

To perform an environmental audit engagement means to investigate the existence of environment related rules within the company, as well as the observance of such rules in the production process, or in the use of equipment or applications. Its benefits for organisations consist mainly in the cost reduction, as well as in the improvement of the company image. The latter is emphasized by the study of McWilliams and Siegel (2000), who showed that *organisations with a good environmental performance are better accepted by consumers, investors, suppliers, non-profit organisations etc.* However, environmental audit is not mandatory and does not necessarily refer to ICT. It is a voluntary activity for most organisations. Still, in the last decades, the number of companies performing environmental audit has exponentially increased. For example, according to information released by the European Environment Agency (EEA, 2012), the number of organisations registered with an eco-management system in compliance with the Eco-Management and Audit Scheme (EMAS) increased by 50% between 2003-2010, while the number of organisations from EU Member States with an ISO 14001 certification became four times higher between 2001-2009. Yet, Ienciu et al. (2012) observe that eco-management systems are mainly found in big-sized entities, with sufficient resources for their implementation and maintenance. Within small and middle-sized entities, the implementation of eco-systems encounters numerous financial restrictions. Even in these circumstances, the environmental concerns are significant. They are stimulated by the measures taken by the regulatory organisations, by the attention paid to this field by

consumers, as well as by the quite significant competition from the IT sector.

However, the environmental audit is not the only form of auditor involvement in the environment protection. The concerns in this matter are also expressed through other audit types, as described in the following section.

#### 4.2. G-ICT related concerns in other audit types

The G-ICT programs (cloud computing, virtualization, outsourcing, data centre re-design and workstation management) lead to important changes, as specified in a study of Juergens (2010) in the ISACA Journal. With no direct reference to environmental management, auditors can test the integration of the pro-environment features of ICT in at least two of the four stages of the equipment life cycle (production, design, use and disposal) (Murugesan, 2010), i.e. in the use stage, as well as at the end of the service life. Considering the omnipresence of the environment - society interaction among the concerns of the international organisations and, generally, of the population, companies should respond to the Greenpeace recommendation (2011), according to which companies need to approach efficiently the own operational emissions, as well as the emissions associated to their products, by setting targets for the decrease of the greenhouse gases in a rational and precisely defined time span, considering the forecasted growth of the ICT sector. Starting from this assertion, within an INTOSAI report (2013) the activities of the G-ICT audit are classified in four main areas (Figure 2).

**Figure 2. Areas of G-ICT auditing**

Source: Author's projection using INTOSAI (2013)

Starting from this classification, we identified the initiatives associated to each component. *At the strategic level*, the G-ICT preoccupations consist in adopting a pro-environment strategy, aiming to the development of a common culture for all the members of the organization, with regard to the eco-system protection. This implies the consolidation of an attitude that people would like to adopt, if a proper framework, adequate tools and training were provided. More, an environment related strategy will contribute to the improvement of the decisions and the initiation of measures meant to narrow the negative effects on the environment, both of the organization's activity, and of the activity of its members. The cost reduction can be a further benefit of adopting a pro-environment strategy, however with long-term results. The auditor can test if such a strategy exists, as well the manner in which it is implemented and observed by all the members of the organization.

*The investments in ICT* are a second component specified by INTOSAI. Following aspects can be considered in supporting the environmental protection: the selection of the equipment and applications based on their environmental impact (energy consumption, CO<sub>2</sub> emissions, estimated service life, raw and other materials employed in their production etc.), the maximization of the equipment's service life, the analysis of the environmental policy of the suppliers of ICT products (both equipment and services). It was

established that, sometimes, the mere replacement of equipment with devices from a more recent generation contributes to a considerable decrease of the energy consumption, but increases the e-waste amount, leading us to the last feature, presented below. Within this last component, a significant role is played by the investments in the eco-innovations from the ICT sector.

Coming to *the use of ICT and ICT solutions*, the auditor can test if the employees observe the environmental strategy, prepared and adopted at strategic level, as well as other specific regulations and rules. They refer to saving energy, using the equipment rationally, reducing the amount of printed paper, designing the informational system so that negative environmental effects are minimized, while positive effects are exploited. This last aspect lies at the intersection of two components: the investments in ICT and the use of ICT solutions. It regards the design and implementation of the informational system, so that the system contributes to the sustainable development of the organization and the business processes, focussing on the management of the information flows, as well as on the increase of their efficiency (Watson, 2008; Sarkis and Zhu, 2008; Sarkis et al., 2013). These are specific features of the green informational systems, together with the energetic efficiency, the rational use of equipments and the e-waste management – aspects associated with the G-ICT. It is thus emphasized a further important feature: *the environment-related aspects are not restricted to equipment and applications, they need to be integrated in the context of the organization as a system, within which G-ICT is only a component, however a highly important one*. The environmental issues also need to be approached from the standpoint of the organizational information flows. We notice the need to prepare feasibility studies with regard to the efficiency and effectiveness of the informational system from the standpoint of the influence on the environment (together with the technical, economic, legal, operational and human feasibility). Starting from all the aspects we mentioned in the context of ICT use, an auditor can assess the extent to which they meet the expectation of the management, from low to reasonable. More, based on their knowledge, auditors can assess the design, implementation and efficiency of the ICT use within the organization, from the standpoint of the environmental impact.

Finally, the last feature specified by INTOSAL refers to *e-waste management*. E-waste is managed efficiently, from the environmental standpoint, by re-using old computers, or still suitable components, respectively by responsibly recycling out-of-service equipment. A particular case is the one of the hardware producers, who should employ recyclable raw and other materials and minimize (up to eliminate) the non-renewable or polluting ones. The use of eco-labels is a usual practice of equipment producers and actively supports the environmental protection. The auditor can test the extent to which such measures are applied for ICT equipment.

A considerable e-waste decrease was called forth by the *virtualisation*, which allows the use of a single server for more simultaneous images of an operating system. In this manner, less equipment is required, meaning that a higher efficiency of the resource use is reached.

As ICT users, the involvement of auditors in the environmental protection can be realised by simple solutions, common to more business areas, like the replacement of desktop computers with portable computers or thin client solutions, as well as the migration of the applications in cloud computing. These generate significant benefits to audit firms: flexibility, data recovery in case of disasters, automatic software updating, reduced investments in equipment, and optimization of the collaboration between members of different organizations. The strategies for the decrease of the energy consumption, the reduction of the required equipment amount and of the waste generated after its use are seen as important contributions of the auditors, as ICT users, to the lowering of negative influences on the eco-system, irrespective of the nature of the performed audit. As a conclusion, auditors should also follow all the recommendations related to environmental protection and ICT, forwarded to the audited organizations.

## 5. Conclusions

The contribution of auditing to the proper realisation of the economic activity of the organisations, as well as of the entire society, is substantial. Its benefits are widely debated and promoted by researchers and practitioners. The less approached integration of the relation with the environment in the audit engagements can lead to significant advantages for the reduction of the natural disequilibrium, called forth by the massive industrialisation of the last centuries. ICT are the most important instrument in the implementation of this endeavour, given their omnipresence in the economic and social activity, including in auditing.

Starting from these premises, the present study analyzed the manner in which audit can influence the transition from ICT to G-ICT. The topic is quite controversial and important, from a moral and a social standpoint, however less attractive from a financial point of view, given the required investments.

In the light of the presented aspects, we consider that the issue of the relationship between the environment and the ICT is complex. It should not be addressed only by the environmental audit, all the more if we consider that environmental audit is not mandatory. Concerns for the eco-system's well-being should be found within all audit forms, out of which our paper mentioned the audit of the informational system and the financial audit. In the final section of the paper, we summarized the attitude that should be shown by auditors, as ICT users, as well as the manner in which they can support the G-ICT, from this perspective. This approach emphasizes even better the complexity of the relationship between audit, environment and ICT.

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