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CONF-IRM 2013 Proceedings

International Conference on Information Resources Management (CONF-IRM)

5-2013

# Green IT Maturity: developing a framework based on practices and actions

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## *Abstract*

In a society whose issues related to sustainability have become increasingly important, the IT area has been responsible for some of the environmental problems that society faces. In this context, Green IT appears as a way of combining available resources to sustainable and economic policies in organizations, generating benefits for the environment and business. The adoption of Green IT practices may create value for companies and society. This study aimed to develop and validate a tool which is able to assess the organizational maturity of Green IT, identifying the main practices adopted and the different components that influence the way organizations have addressed environmental sustainability in the IT field. The framework proposed in this study has suggested four constructs to assess the organizational maturity of Green IT: *socio environmental awareness* of the organization; *sustainable actions applied to IT field*; *IT activities monitoring*; and *search and update of approaches regarding the use of IT*. Results are expected to motivate not only students but also practitioners who study and implement different Green IT initiatives, so that organizations can become more efficient and effective and commit to the planet conservation, as well.

## *Keywords*

Green IT, Sustainability, Green Practices, Framework, Validation

## 1. Introduction

Issues related to sustainability have become increasingly important in research and in practices carried out by organizations in the last decades as a result of shortage of natural resources and concerns over wealth disparity and corporate social responsibility (Dao, Langella & Carbo, 2011). The technological revolution has led to the development of superfluous consumerism which has originated social behavior towards waste, exaggerated consumerism of resources and omission related to its effects on the environment. In general, society has been more interested in what nature can offer rather than worried about the damage humans are causing. Therefore, this situation, which has grown since the beginning of industrialization, has brought forward severe problems to the useful life of natural resources and led to their shortage. It has also spread to several sectors of the economy, a fact that has

made authorities, the civil society and companies propose different measures to help save the planet and, consequently, future generations.

In the area of Information Technology (IT), several environmental problems have been identified so far, such as: high electric power consumption (which also contributes to gas emissions), high use of non-renewable resources that are used for computer and accessories equipment manufacturing and the discharge of obsolete devices (Ozturk et al., 2011). According to Murugesan (2008), IT represents a meaningful part of environmental issues which society has faced these days.

As a reaction, profound changes in social values have redirected competitiveness in the market and led to the development of ecologically correct goods – a result of the so-called "green" movements; their main aim is to mitigate pollution and spend less to manufacture goods and implement services (D'Souza et al., 2006). Regarding IT, this movement has been called Green IT (Molla et al., 2008). The concept was created by technology companies which aimed to incorporate sustainability policies and cost reduction strategies into their organizations so as to generate benefits to the environment and the companies.

To "go green" has become an essential activity that IT leaders have to carry out (Gartner, 2010). Environmental management has been increasingly called for by regulatory agencies, consumers and the general public. As a result, several organizations have spent time and resources to protect the environment by implementing strategies to mitigate the impact of their operations, besides rationalizing energy consumption and waste generation (Ko, Clark & Ko, 2011). Since computer equipment has become more popular and financially accessible to the population, the IT industry (which supplies the goods) and the organizations (which are the users of technological products) have to face strong pressure to become more sustainable regarding environmental issues. This challenge has affected design, production and use of computers, besides servers, software and accessories in the search for efficient and effective ways to mitigate environmental damage.

In this context, adopting Green IT practices may create value for organizations and society, besides enabling these organizations to operate in a more sustainable way not only by saving energy, paper, water, transportation, physical space, maintenance and waste, but also by improving their image, respecting the environment and enriching their employees (Lunardi, Frio & Brum, 2011). However, traditional approaches to measure the value of IT have failed to recognize that the environmental challenges managed by Green IT are different from operational challenges which are usually managed by the IT staff (Melville, 2010), especially the importance of the ethical and sustainability have in the decision-making process. While the adoption of an IT is usually motivated by the potential economic benefits of using this technology, green IT practices are also motivated by a concern towards the planet, even if the economic benefits may not be tangible in the short term.

Thus, we aimed to develop and validate a tool which is able to assess the organizational maturity of Green IT, identifying the main practices and different components that influence the way organizations have addressed environmental sustainability in the IT area.

# 2. Background and literature aspects

## 2.1. Green IT and its practices

Since Green IT is a relatively new research area – which has drawn the attention of academic researchers (Brooks, Wang & Sarker, 2010) –, its study requires theorization, construction of models and development of measures (Hair et al., 2009). Therefore, the proposal of a specific

method which shows the multidimensional nature of Green IT may enable users to choose strategic options in order to make their IT area more sustainable. Few studies have shown the development and validation of reliable tools to measure the Green IT construct (Molla, 2009). Applying measures associated with Green IT may lead to the identification of what organizations need to become greener and how much they have advanced towards Green IT.

Green IT has been used as a general term for measures and activities that are carried out in the IT departments in companies that aim to organizational sustainability and social responsibility (Chen et al., 2008; Schmidt et al., 2010). It is the study and the practice of design, manufacture, use and discharge computers, servers and associated subsystems (monitors, printers, storage devices and communication nets and systems), efficiently and effectively, with low impact on the environment, pursuing financial viability and improvements regarding the use and performance of the systems and respecting social and ethical responsibility (Murugesan, 2008).

Green IT may be seen as a holistic and systematic approach to face the challenges surrounding the IT infrastructure, since it contributes to mitigate environmental damage resulting from its activities, supporting environmentally sustainable business practices and plays its role in the low-carbon economy (Molla et al., 2008). Therefore, it takes into account the whole life cycle of information and communication technologies by applying environmentally correct design, production, operation and discharge processes (Elliot, 2007).

Adopting Green IT is different from adopting any IT, mainly because of the importance that is given to issues related to ethics and sustainability in the decision making processes. Adopting any IT is usually motivated by potential economic benefits when this technology is used whereas Green IT practices are also triggered by the concern towards the planet, even if the economic benefits may not be reachable in the short term. To deal with these issues, organizations that care about their social and environmental responsibilities, business sustainability and Green IT have written clear policies regarding the equipment they buy (less energy consumption, more recycled and non-polluting materials), the use of computers and printers (more efficient computational processes, virtualization, less printing, cartridge re-manufacturing, recycled paper) and the way the layout of datacenters and computer rooms (small, less-consuming and better refrigerated ones).

Lunardi, Frio and Brum (2011) identified 37 different Green IT practices which have been carried out by organizations. These practices were classified into seven categories: awareness practices; green datacenter; discharge and recycling; alternative sources of energy; hardware; software; and printing (Table 1). Even though some of these practices require high investment – mainly the ones concerning datacenters, alternative sources of energy and replacement of obsolete equipment – other sustainable practices can be adopted without compromising the company's financial health, just depending on the users' effort and good will, besides the support and direction of the organization.

Several leading companies have focused on these issues. As a result, Green IT initiatives will soon become part of the companies' core business, rather than specific and isolated projects. It means two equally important challenges for the IT management: firstly, IT managers will be asked to minimize energy consumption, emissions, inefficiency and waste in the area; and, secondly, IT managers must provide solutions that enable companies to measure, monitor, report and mitigate the environmental impact they cause. These challenges must be faced along with the need to prove that the investments in IT were worth it (Molla, Cooper & Pittayachawan, 2011).

| Green IT Practices |
|---|
| **Awareness Practices** |
| Awareness raising campaigns |
| Green suppliers |
| Sustainability policy |
| Teleworking/videoconferencing |
| Green building |
| Sustainability committee |
| Energy efficiency analysis |
| **Green Datacenter** |
| Server consolidation and virtualization |
| Desktop virtualization |
| Datacenter update |
| Outsourcing server management |
| **Discharge and Recycling** |
| Recycling computer parts, cartridges and equipments |
| Appropriate discharge |
| Material collection |
| Equipment donation |
| Incentive for recyclers |
| Regulatory laws |
| Trade-in (old equipment is handed in when new one is bought) |
| **Alternative Sources of Energy** |
| Use of renewable sources or energy |
| Use of heat for other objectives |
| Water recycle and reuse |
| **Hardware** |
| High efficiency equipments |
| LCD monitor replacement |
| Elimination of toxic components |
| New products with recycled components |
| Extending product life cycle |
| **Printing** |
| Outsourced printing |
| Monitored printing |
| Document digitizing |
| Double-sided printing |
| Printer consolidation |
| Use of recycled paper |
| Use of multifunctional equipments |
| **Software** |
| Energy Management Systems |
| Efficient software application |
| Control systems (gas emission, quality of water) |
| Systems to design more efficient products |

**Table 1** - Main Green IT practices in organizations

Green IT comprises the management of all activities and measures which aim to decrease resource consumption, in the case of energy, for instance, in the IT department. Besides, it includes tools to control, guide and communicate practices that have been carried out (Schmidt et al., 2010). Emission and use of energy are significant parameters that need to be measured to assess the environmental impact caused by IT (Molla, 2009). Inefficient use of energy does not only harm the environment but may also result in high costs and make organizations lose competitive advantages in the market. Intelligent technology management may be an alternative solution to help companies mitigate damage caused to the environment,

improve the effectiveness of electrical energy consumption and decrease operational costs in the business. Environmental management systems monitor and assess the environmental performance of organizations that use them as a tool for constant improvement of the environmental conditions (Melville, 2010).

In addition, it is very important when organizations are willing to try, update and look for new approaches, information and knowledge about the use of equipment and services in order to support strategies of environmental sustainability in the IT area (Mines, 2008). These initiatives aim at keeping the organization committed to the organizational strategies by maintaining or decreasing operational costs, mitigating waste and optimizing the consumption of electrical energy in the processes of the organization's value chain (Elliot & Binney, 2008). Kim and Ko (2010) have highlighted that organizations that do not care about collecting and updating knowledge about the sustainability of their activities are prone to increase production costs as a result of their investments and operational costs.

## 2.2 The perception of value in the light of Green IT

Leading organizations have adopted a holistic approach regarding environmental impacts caused by IT, rather than narrow-minded views, to perceive the value of their investments in Green IT in different ways. The value of Green IT has been the object of several discussions. Some authors have argued that Green IT has very high implementation costs (Fuchs, 2008), whereas others have emphasized the economic benefits that arise from Green IT initiatives (Velte et al., 2008) and have stated that Green IT may result in competitive advantage to the organizations (Setterstrom, 2008).

Although several authors have recognized the social value of IT, some of them still focus on individual impacts caused by IT. Chow and Chen's research (2009), for instance, has shown that, in an individual level, users' attitudes towards Green IT have a significant effect on their intention to apply it. However, it is important to make sure that models which identify and measure the value of Green IT must take into account all impacts, such as the financial one and broad social and environmental benefits.

Benefits may be direct (such as financial ones, operational agility and competitive advantages in the market) or indirect (such as non-financial ones, increase in the human capital and innovation in the information production and maintenance processes). Models that aim at measuring value created by IT must propose variables for qualitative and quantitative analyses to explain multidimensional relations. Examples of variables are quality, productivity, innovation and organizational learning, besides factors of environmental and social performance to assess benefits *versus* costs (Corbett, 2010).

# 3. Method

This exploratory quantitative study was carried out in 44 companies located in Rio Grande do Sul state, in the south of Brazil. Respondents (n = 173) were IT users and managers in their companies. The research comprised an exploratory phase to identify different indicators associated with Green IT so that a tool for data collection could be elaborated and a quantitative phase which comprised data collection, validation and analysis. The methodological procedures have been described below.

The tool for data collection was based on results from a literature review in Green IT. Papers published in journals, congress annals and magazines were reviewed; the focus was the practices carried out by companies and different components that affect the way they address

environmental sustainability in the IT area. This search resulted in the proposal of a framework which is able to assess the organizational maturity of Green IT through four factors:

a) **Socioenvironmental awareness**: To develop Green IT results, the organization must be aware of the need to address environmental issues in a pro-active way, develop a green IT policy, outline objectives, targets, action plans and deadlines to implement these strategies effectively (Ko, Clark & Ko, 2011; Dick & Burns, 2011; Ozturk et al., 2011).

b) **IT Sustainable Actions**: To develop Green IT results, different practices must be carried out by the organizations so that IT activities can become more sustainable, using computer resources efficiently and contributing to the environment (Murugesan, 2008; Molla et al, 2008; Brooks et al., 2010).

c) **IT activities Monitoring**: To develop Green IT results, all IT activities and measures must be managed. They must aim at decreasing resource consumption, mitigate damage caused to the environment, improve effectiveness in energy consumption and diminish the operational costs of the business (Molla, 2009; Melville, 2010; Schmidt et al., 2010).

d) **Search and update:** To develop Green IT results, the organization must be willing to try, update and look for new approaches, information and knowledge about the use of equipment and services in order to support environmental sustainability strategies in the IT area (Elliot & Binney; 2008; Kim & Ko, 2010; Mines, 2008).

After the definition of the dimensions, the constructs were formally converted into measurable variables. Twenty eight variables were turned into questions and grouped according to their association with the constructs. After the questions were formulated and theoretically supported, a structured questionnaire was made. Two tools were designed: one of them was aimed at the person who is responsible for the IT area in the organization; the other one was aimed at common users. The only difference between them was a question with 14 Green IT practices, suggested by Lunardi, Frio and Brum (2011), to be answered by the IT manager if each practice was presented in its company. Closed questions were operationalized in a 5-point Likert scale (from “strongly disagree” to “strongly agree”). Figure 1 shows the conceptual model of the research.

## 4. Results

The tool used for data collection was applied in 44 companies located in a city in the south of Brazil. Four questionnaires were left in each company; one should be answered by the person who was responsible for the IT area and the others by IT users and managers in the company. Companies were chosen by convenience through personal contacts. At the end of the study, 180 questionnaires were answered; however, 173 were considered valid: 44 (25.4%) were answered by IT managers and 129 (74.6%) by managers and IT users who worked in other administrative areas. The sample was characterized in Table 2.

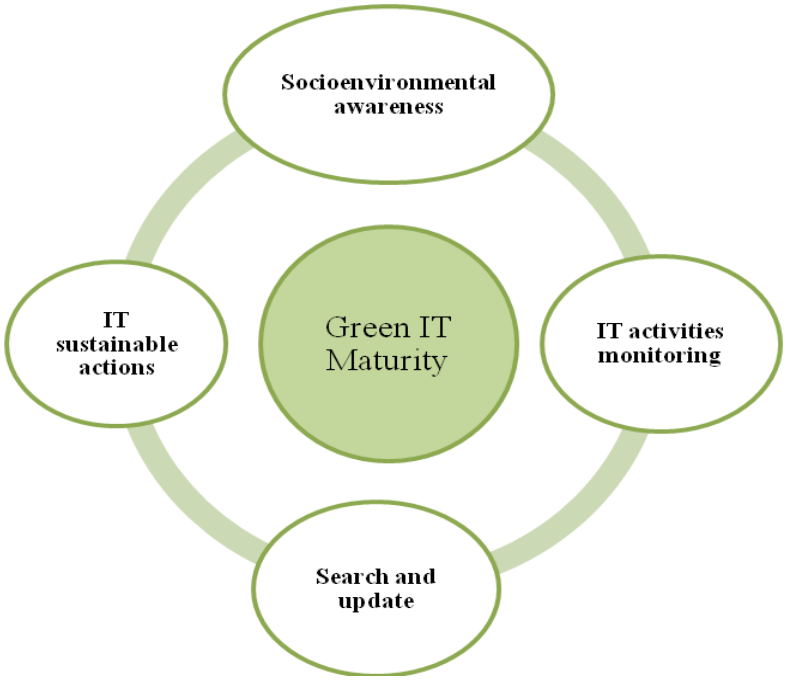


**Figure 1** - Conceptual model

| Characteristics | n | % |
|---|---|---|
| **Economic Sector** | | |
| Industry | 5 | 11.4 |
| Commercial | 18 | 40.9 |
| Services | 10 | 22.7 |
| Public Services | 11 | 25 |
| **Size company** | | |
| Micro | 9 | 20.5 |
| Small | 11 | 25 |
| Medium | 7 | 15.9 |
| Large | 16 | 36.4 |
| n/a | 1 | 2.3 |
| **IT area** | | |
| Own | 35 | 79.5 |
| Outsourced | 9 | 20.5 |
| **Total** | **44** | **100** |
| **Computers Average = 65.25** | | |
| **Job Position** | | |
| Administrative Staff | 98 | 55.5 |
| Supervision | 19 | 8.1 |
| Management | 46 | 8.7 |
| n/a | 10 | 5.8 |
| **Education Level** | | |
| High School | 37 | 21.4 |
| Incomplete University Graduate | 70 | 40.5 |
| Complete University Graduate | 45 | 26.0 |
| Postgraduate | 15 | 8.7 |
| n/a | 6 | 3.5 |
| **Total** | **173** | **100** |

**Table 2**: Characterization of the Sample

After data collection, two statistical tests were carried out in order to guarantee the validation of the instrument: the exploratory factor analysis and the Cronbach's alpha (Table 3). Applying the exploratory factor analysis (with Varimax rotation) confirmed the four factors that had been proposed, in accordance with two criteria: the degree of association among variables and their degree of subjectivity. Six questions were eliminated from the original tool because they either had no conceptual coherence or had low correlation with the other items of their groups. The four dimensions of the tool explain 61.81% of the variation of the original questions; it represents an adequate degree of data synthesis and made their interpretation easier. The reliability of the dimensions of the tool was tested by Cronbach's alpha. The instrument score was 0.93, whereas the coefficients of the factors ranged between 0.82 and 0.87, showing good internal consistency for exploratory studies.

Regarding the main practices carried out by the companies under analysis, the most common ones (66.7%) are the use of more efficient equipments, document digitizing and LCD monitor replacement. The second group comprises printing monitoring, material collection, appropriate discharge and recycling computer parts, cartridges and equipments whereas sustainability programs, awareness raising campaigns, preference for green suppliers, datacenter update and desktop consolidation appeared as practices cited, but were less frequently.

After the performance of the validation procedures, we analyzed the organizational maturity of Green IT (Table 4). It can be observed that, taking into account all components which influenced the way how organizations have addressed environmental sustainability in IT, Green IT actions are the most developed ones (3.59). The score is very close to the mean point in the scale which shows that sustainability in IT area can still be further developed. The most effective actions that have been perceived by the respondents are the removal of computer equipment that has not been used (3.89) and the purchase of technological equipments in terms of energy efficiency (3.75).

With the emergence of devices and increasingly modern equipments and the constant updating of technology parks by companies, the obsolescence has become a highly critical point when it comes to responsible disposal. The rate of production of new computers and accessories is proportional to the volume of e-waste that is generated, which implies the development of different strategies of disposal, such as the reuse of these products (distributing them internally, making donations or delivering them to own suppliers), correct disposal, gathering materials, and recycling of parts and equipments (Lunardi, Frio & Brum, 2011). Since the acquisition and possession of more efficient technological equipments have as main objective the reduction of spending power, cooling and own operating costs of IT. Energy costs represent a significant proportion of the total cost of operation of infrastructure and IT assets (Rasmussen, 2006), which has made the reduction of energy costs and improve energy efficiency a top priority of executives (Thibodeau, 2007; Dedrick, 2010). In turn, actions that respondents worry less about are the purchase of computer products with no dangerous materials (3.31) and with a quality green stamp (3.28).

Monitoring IT activities (3.40) - whose average rating is shown slightly above the midpoint of the scale used –appears then. The control of maintenance costs with computer equipments (3.68), along with printing what is actually needed for the tasks and the business (3.66) are the most effective monitoring activities. Printing documents is very much related to the users' perception of what must really be printed whereas better control of maintenance costs is

justified by high costs of repairs (many are related to the fact that users neglect the equipment). However, printing monitoring (3.11), the fourth most common Green IT practice mentioned in the survey, and the management of energy consumption in the computers (3.08) are the less effective activities.

| Indicators | Block | F1 | F2 | F3 | F4 |
|---|---|---|---|---|---|
| **IT Sustainable Actions** | | | | | |
| q06. The company has more efficient equipment based in energy | 0.832 | 0.767 | | | |
| q12. The company makes removal equipment unusable computing | 0.772 | 0.738 | | | |
| q13.The company has made the latest purchases considering energy efficiency | 0.821 | 0.735 | | | |
| q10. The company implements strategies to improve utilization of computer products (hibernate function, cooling, physical area, virtualization) | 0.764 | 0.634 | | | |
| q08. The company purchases computer products without dangerous materials (ex. mercury and lead) | 0.671 | 0.627 | | | |
| q07. The company carries dispose of electronics products | 0.464 | 0.620 | | | |
| q09. The company purchases computing equipments with green seal of quality | 0.660 | 0.551 | | | |
| **Search and Update** | | | | | |
| q22. The company has aware of how different technologies can operate more efficiently | 0.829 | | 0.753 | | |
| q20. The company has knowledge about computer technologies cleaner and more efficient sources existing on the market | 0.829 | | 0.710 | | |
| q24. The company uses different sources to identify cleaner and more economic computational trends (seminars, books, articles, consulting) | 0.842 | | 0.675 | | |
| q21. The company seeks new ways to reduce the energy consumption of computer products (computers, servers, datacenters) | 0.766 | | 0.659 | | |
| q23. The company seeks to identify cases of other companies that have saved energy and money through the use of cleaner computer technologies | 0.769 | | 0.642 | | |
| **Socioenvironmental Awareness** | | | | | |
| q01. The company has well defined environmental policies and strategies | 0.836 | | | 0.815 | |
| q04. The company may be considered environmentally sustainable | 0.812 | | | 0.709 | |
| q02. The company has strategies and policies for the use of natural resources (water, electricity, paper) | 0.707 | | | 0.698 | |
| q03. The company looks for business partners who have environmental concerns | 0.755 | | | 0.600 | |
| q15. The company gets used to inform employees about recycling and disposal of computing equipment in the company | 0.704 | | | 0.528 | |
| **IT Activities Monitoring** | | | | | |
| q25. The company controls the printing of documents made by employees | 0.729 | | | | 0.826 |
| q26. The company manages the power consumption of the different computer technologies | 0.881 | | | | 0.695 |
| q27. The company controls maintenance costs of computer equipment | 0.815 | | | | 0.682 |
| q11. The company prints what is really needed for the activity and for business | 0.594 | | | | 0.656 |
| q28.The company manages the performance of computing equipment | 0.806 | | | | 0.518 |
| **Initial eigenvalue** | | **8.92** | **1.81** | **1.59** | **1.28** |
| **% Explained variance - Rotated (61.81%)** | | **40.5%** | **8.2%** | **7.2%** | **5.8%** |
| **Cronbach's alpha (instrument = 0.93)** | | **0.86** | **0.87** | **0.82** | **0.82** |
| **KMO (measure of sampling adequacy) = 0.895** | | | | | |
| **Bartlet test: chi-square = 1873.834** | | | | | |

**Table 3 -** Factor analysis (Varimax rotation)

| Indicators | n | Average | Standard Deviation |
|---|---|---|---|
| **IT Sustainable Actions** | **171** | **3.59** | **0.87** |
| q.12 The company makes removal equipment unusable computing | 168 | 3.89 | 1.08 |
| q13. The company has made the latest purchases considering energy efficiency | 171 | 3.75 | 1.17 |
| q.06 The company has more efficient equipment based in energy | 171 | 3.68 | 1.17 |
| q.07 The company carries dispose of electronics products | 171 | 3.65 | 1.26 |
| q.10 The company implements strategies to improve utilization of computer products (hibernate function, cooling, physical area, virtualization) | 171 | 3.54 | 1.17 |
| q.08 The company purchases computer products without dangerous materials (ex. mercury and lead) | 170 | 3.31 | 1.21 |
| q.09 The company purchases computing equipments with green seal of quality | 169 | 3.28 | 1.20 |
| **IT Activities Monitoring** | **171** | **3.4** | **0.93** |
| q27. The company controls maintenance costs of computer equipment | 171 | 3.68 | 1.11 |
| q11. The company prints what is really needed for the activity and for business | 170 | 3.66 | 1.33 |
| q28. The company manages the performance of computing equipment | 169 | 3.47 | 1.16 |
| q25. The company controls the printing of documents made by employees | 171 | 3.11 | 1,37 |
| q26. The company manages the power consumption of the different computer technologies | 169 | 3.08 | 1,16 |
| **Search and Update** | **171** | **3.33** | **0.98** |
| q22. The company has aware of how different technologies can operate more efficiently | 171 | 3.60 | 1.09 |
| q21. The company seeks new ways to reduce the energy consumption of computer products (computers, servers, datacenters) | 171 | 3.53 | 1.21 |
| q20. The company has knowledge about computer technologies cleaner and more efficient sources existing on the market | 171 | 3.47 | 1.14 |
| q23. The company seeks to identify cases of other companies that have saved energy and money through the use of cleaner computer technologies | 171 | 3.16 | 1.16 |
| q24. The company uses different sources to identify cleaner and more economic computational trends (seminars, books, articles, consulting) | 171 | 2.97 | 1.17 |
| **Socioenvironmental Awareness** | **171** | **3.24** | **0.96** |
| q15. The company gets used to inform employees about recycling and disposal of computing equipment in the company | 171 | 3.39 | 1.31 |
| q02.The company has strategies and policies for the use of natural resources (water, electricity, paper) | 171 | 3.35 | 1.20 |
| q03.The company looks for business partners who have environmental concerns | 169 | 3.32 | 1.18 |
| q01.The company has well defined environmental policies and strategies | 170 | 3.24 | 1.23 |
| q04. The company may be considered environmentally sustainable | 169 | 2.91 | 1.36 |

**Table 4** – Descriptive Analysis – Organizational Maturity of Green IT

Regarding search and update (3.33), knowledge of how computer technologies may work more efficiently, or which cleaner and more efficient ones can be found in the market, is also moderate. When an organization is updated and looks for new approaches, information and knowledge about what is available in the market, it tends to mitigate its operational costs since it is investing in a more efficient technology. The result is a positive relationship between the adoption of green practices and the company's financial results (Kim & Ko, 2010). On the other hand, knowledge of successful cases of companies that have applied Green IT (3.16) and the identification of computer tendencies (2.97) is less effective; it shows that there is a reaction against the promotion of environmental sustainability through IT.

Regarding socioenvironmental awareness (3.24), this group of activities is the less effective when all four dimensions are evaluated. Although the politically correct strategies in relation to the environment are gaining space in the list of priorities of executives, such awareness has not arrived with the same intensity in the various organizational levels, even small changes

could represent significant environmental and economic gains. All items in this group were moderately evaluated; it shows that there is lack of a well-defined environmental policy by the organizations as well as its strategies in the respondents' perception (2.91). It is worrying because it will be hard to find sustainability in the IT area if it, and mainly, the IT staff are not aware of the need to face socioenvironmental issues more proactively (Ko, Clark & Ko, 2011; Ozturk et al., 2011) with the fundamental support of the board of directors. For Green IT initiatives work, it is essential that corporate green policies be developed, especially to define "where to start". Once initiated some of these initiatives, others will come as a result of corporate consciousness.

Regarding the main practices carried out by the companies under study, the use of more efficient equipment (n= 35; 79.5%), the documents digitizing (n = 33; 75%) and the replacement of monitors (n=28; 63.6%) appear as the practices most commonly adopted by companies analyzed. The following group comprises: printing monitoring (n = 26; 59.1%); material collection (n=25; 56.8%); adequate discharge (n=24; 54.5%); and recycling of computer parts (n = 22; 50%). Finally, some less common practices are: server consolidation (n = 14; 31.8%); desktop consolidation (n = 11; 25%); preference for green suppliers (n = 11; 25%); datacenter modernization (n= 10; 22.7%); awareness campaigns (n = 9; 20.5%); and the application of sustainability programs (n = 5; 11.4%).

# 5. Final Comments

This study led to the elaboration and validation of a tool which is able to analyze the organizational maturity of Green IT, taking into account different components that affect the way organizations have approached environmental sustainability in the IT area. Four constructs were proposed: *socioenvironmental awareness*, *IT sustainable actions*, *IT activities monitoring* and *search and update*. The results provided by 173 respondents showed that the sustainability **actions** are more effective than the other dimensions. **Socioenvironmental awareness** is the construct that had the lowest average among the variables under analysis; it means that environmental issues have not become a priority in the companies under study yet. The four dimensions we defined as organizational maturity of Green IT can be used as a measure of a company's IT development strategy and commitment to the main goals of sustainability. Results indicate that the importance of Green IT for organizations is still understated and more can be done in reducing the IT environmental impact and solving sustainability issues.

Regarding the practices adopted by the companies, the most common ones are: the use of more efficient equipments, in terms of energy; document digitizing; replacement of monitors and printing monitoring so that users' waste can be mitigated. These measures aim at decreasing the high energy consumption in IT, as well as the amount of paper used for printing. Such actions lead to economic and environmental benefits. Practices regarding to IT recycle and disposal of IT in an environmentally friendly manner are getting more frequently, showing that organizations are becoming more concerned about these kind of environmental problem. On the other hand, expensive technologies evolving data centers and desktops consolidation are still not widely adopted, even though these practices can enormously reduce the energy consumption.

It may also be noticed that the least effective practices in the organizations are the ones related to awareness campaigns and sustainability programs. Obviously, these practices involve a more complex dimension in the organization, regarding its behavior and culture. Since most organizations do not have proactive concern related to sustainability issues, their environmental policies and strategies are neither clear not spread all over the organization. The evidence is the low average of the construct **socioenvironmental awareness** in this study.

This research contributes to the IT area regarding an issue that has drawn the attention of researchers and practitioners in several areas, since the interaction between IT and environmental sustainability has been the subject of very few studies. As a practical contribution, we provide a tool that can be used by any organization to assess how sustainable its activities in IT are. It can follow its evolution and identify different Green IT practices that can be routinely carried out in the company.

One of the limitations of this study is the number of companies under investigation, even though the respondents' answers and the results are based on the users' perceptions, rather than on the organization's perceptions. Results are expected to motivate not only students but also practitioners who study and implement different Green IT initiatives, so that organizations can become more efficient and effective and commit to the planet conservation, as well.

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