Green IT and the right portfolio of sustainable projects

A TI Verde e o correto portfólio de projetos sustentáveis

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Abstract: Sustainable development in the information technology industry is known as Green IT. Considering the need to generate consistent and sustainable IT projects, this paper presents a study on how Green IT criteria are used in the portfolio selection of information technology infrastructure projects. Method used was the multiple case studies, characterized by a qualitative evaluation. Object of this work was composed of sustainable companies whose shares are traded on the stock exchange, considering sustainability indexes. In addition to analysing the project portfolio management process, this work identified ten criteria that can be used to select information technology projects. We found that these criteria are not cost generators, but act on the tripod of cost reduction, maintenance or performance improvement and sustainability.
Keywords – Sustainability Indexes; Sustainable Development; Criteria; Portfolio and Project Management; Green IT.

Resumo: O desenvolvimento sustentável no setor de tecnologia da informação é conhecido como TI Verde. Considerando a necessidade de gerar projetos de TI consistentes e sustentáveis, este artigo apresenta um estudo sobre como os critérios de TI Verde são usados na seleção de portfólio de projetos de infraestrutura de tecnologia da informação. O método utilizado foi o estudo de caso múltiplos, caracterizados por uma avaliação qualitativa. O objeto deste trabalho foi composto por empresas sustentáveis cujas ações são negociadas em bolsa, considerando índices de sustentabilidade. Além de analisar o processo de gerenciamento de portfólio de projetos, este trabalho identificou dez critérios que podem ser usados para selecionar projetos de tecnologia da informação. Descobrimos que esses critérios não são

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geradores de custos, mas atuam no tripé de redução de custos, manutenção ou melhoria de desempenho e sustentabilidade.

Palavras-chave – Índices de Sustentabilidade; Desenvolvimento Sustentável; Critérios; Gestão de Projetos e Portfolio; TI Verde.

Introduction

Information technology (IT) has diametrically opposed relations in the field of sustainability. In a positive respect, IT implements new technologies that change traditional work forms, resulting in better use of natural resources (Murugesan, 2008). These work methods emphasize social aspects, without harming economic and financial results. On the other hand, IT also accelerates processes that are harmful to the environment, such as being a large consumer of electricity and generating discarded electronics (Bachour & Chasteen, 2010).

The most widespread use of sustainable processes in IT has been a growing concern for environmentalists and experts. Authors like Bachour and Chasteen (2010), Faucheux and Nicolaï (2011), Molla (2009), Molla and Abareshi (2012), Murugesan (2008) Widjaja et al., (2011), describe both the processes that minimize the harm caused by IT (known as "Green for IT" or "Green IT") and processes that maximize its positive effects (known as "IT for Green"). In this paper, the concepts will be combined and referred to as Green IT.

To be put into practice, Green IT actions rely on technological changes, which in turn, are implemented as projects. To Carvalho and Rabechini Jr. (2015), Gareis et al. (2013), Maltzman and Shirley (2012) and Silvius et al. (2012), it is essential to assess aspects of sustainability in project management environment, considering the awareness that the results of projects will have long-term consequences, addressing the short time vision of project completion.

There has been a growing discussion of project management associated with sustainability with a focus on Green IT in the literature (Armenia et al., 2017; Gareis at al., 2013; Martens & Carvalho, 2017; Maltzman & Shirley, 2012; Sanchez, 2015; Silvius et al. 2012; Turner et al., 2010; Weninger et al., 2013). Several studies (Bachour & Chasteen, 2010; Faucheux & Nicolaï, 2011; Molla, 2009; Molla & Abareshi, 2012; Murugesan, 2008), suggest the adoption of Green IT practices in problem solving with a focus on existing infrastructure. However, they devote little attention to assessing how new projects should be selected considering Green IT criteria. The study of the relationship between project

portfolio selection and Green IT is configured as an alternative to improve understanding of how to improve the progress of Green IT implementation. One of the points in which the two areas interact is the selection of projects to be undertaken. The definition of Green IT criteria that can be easily identified and used in this selection aids the practices of project portfolio management.

The present paper contributes to the research on this phenomenon by formulating and answering the following research question: How are Green IT criteria used in selecting a portfolio of information technology infrastructure projects? With this, we hope to point out the influence of Green IT criteria on the formation of a portfolio of IT infrastructure projects. We hope to propose a framework of useful elements for IT governance in keeping with the strategic objectives of organisations.

The research method chosen to address this issue was a multiple case study in companies engaged in the issue of sustainability, characterized among those on Dow Jones Sustainability Index (DJSI) and the Corporate Sustainability Index (ISE) of BM&FBOVESPA (Brazilian Stock Exchange). Initially, the literature on portfolio management issues in IT and sustainability was revised to identify a set of proxy data for the construction of a conceptual model. Two sets of variables were identified: one representing the selection criteria for new projects and the other for the governance management of IT projects, respectively. We then evaluated the experiences of six large organisations with a focus on the fields of sustainability and IT. With the survey data obtained from these organisations, the report was developed based on comparative research, with cross-evaluation of cases.

The results showed that Green IT is incorporated into ten criteria that are used to select projects, and it is evaluated in the organisation's portfolio management. It should be noted that these criteria do not mean higher costs for the organisations but are incorporated into technological solutions that meet the constraints of cost, performance and sustainability. We also found that the advance of new technologies renders previously adopted solutions obsolete, requiring a constant review of Green IT criteria for project selection.

Theoretical Background

Due to the awareness that the resources of the planet are finite and the responsibility of guaranteeing the next generations (Barbieri, 2011), concepts such as sustainable development and sustainability are increasingly used, reaching the political and economic agenda, as part of the strategy

of many organisations. (Nidumolu et al., 2009). The theme of sustainable development is relatively recent and its most well-known definition, proposed by the "World Commission on Environment and Development: Our Common Future", considers it "the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987, p.6). Elkington (2001) supplemented this concept by proposing that it be supported by three pillars, which became known as the Triple Bottom Line of the needs of an organisation for sustainable development. The Bottom Line (expression that also means the last line of a financial report, i.e. profit) suggests that companies cannot focus solely on economic outcomes, but also on social and environmental outcomes (Silvius et al., 2012).

While principles of sustainable development are evident at the corporate level, they remain incipient in project management, whether in the practical or academic environment (Carvalho & Rabechini Jr., 2015). Considering that around 30% of global GDP is initiated by projects (Turner et al., 2010), sustainable development principles must be part of project management methodologies, since the impact on society, the environment and economy is felt during the execution of a project and after its completion. The first step in this direction can be taken when choosing which projects to undertake, ensuring that sustainable practices are also maintained in the decision-making process (Labuschagne & Brent, 2004; Khalili-Damghani et al., 2013; Neumüller et al., 2016). This discipline under project management is known as portfolio management, and it is important to evaluate the main conceptual aspects of it and evolve to the integration of the principles of sustainability applied to portfolio management.

Portfolio can be defined as a set of projects, programs or operations, managed as a unified entity and intended to meet the strategic objectives of the organisation that undertakes them, allowing these elements to be measured, classified and prioritized (PMI, 2013). Portfolio management assists an organisation's management in strategic choices regarding the projects to be undertaken, allocating available and necessary resources for its implementation, and balancing these resources among the projects in execution. As a selection method, we used mathematical models, financial models and indexes, financial probabilistic models, pricing theory, strategic approaches, scoring models and checklists, hierarchical analysis approaches, behavioural approaches, analysis processes and bubble diagrams (Castro & Carvalho, 2009; Cooper et al., 1999; Padovani et al., 2010).

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Despite the different methods, the selection of the project portfolio presents difficulties in reaching a consensus as to what should be chosen. Among the factors that accentuate this scenario, Ghasemzadeh and Archer (2000) and Shenhar and Dvir (2010) point out that the objectives of the organisation are not always the same. Indeed, they are often in conflict. Furthermore, risks and uncertainties permeate the whole process (Cooper et al., 1999; Ghasemzadeh & Archer, 2000) and number of viable projects is frequently much greater than the organisation's ability to undertake them (Gavira et al., 2007). The selection of IT projects is no different. The criteria used to select projects involve the aforementioned models, and to these the Green IT criteria should be added.

The background literature, as can be detected in the Table 1 and Table 2, shows two main categories of criteria that differentiate Green IT projects from the others. There are those that deploy new technologies, which in turn alter traditional ways of working and those that help to reduce the consumption of natural elements. These are typical Green IT projects; whose results are visible outside the IT environment. The literature and results of pilot research identify telepresence, teleworking, dematerialization and the use of smartphones and tablets as criteria for the selection of these projects. A summary of these criteria is presented in Table 1.

Table 1
Synthesis of criteria for selecting projects whose results are evident outside the IT environment.

Criteria	Concept	Authors
Telework	Ability to work from home	(Bachour & Chasteen, 2010), (Fuchs, 2006), (Moos et al. 2006), (Ruth, 2011)
Telepresence	Participation in virtual meetings instead of traveling	(Bachour & Chasteen, 2010), (Ruth, 2011)
Dematerialization	Physical goods (such as paper, CDs DVDs, newspapers) transformed into bits (digital content)	(Bachour & Chasteen, 2010), (Toffel & Horvath, 2004), (Ruth, 2011)
Usage of smartphones and tablets	Reduction of paper	Mentioned in the pilot research

Source: Prepared by the authors

Regarding the perception of IT as a major consumer of resources and as an undesirable waste generator (Murugesan, 2008), Green IT criteria seeks to ensure that these projects consider concepts that minimize these effects (Bachour & Chasteen, 2010; Faucheux & Nicolaï, 2011; Molla, 2009; Molla & Abareshi, 2012; Murugesan, 2008; Widjaja et al., 2011). In this case, unlike the set described in Table 1,

the results are felt in the IT environment itself. These criteria are described in Table 2, together with the authors who support them.

Table 2
Synthesis of criteria for selecting projects whose results are verified within the IT environment.

Criteria	Concept	Authors
Server virtualization	Using servers with higher processing power accommodating multiple virtual servers	(Appasami & Suresh, 2011), (Bachour & Chasteen, 2010), (Molla & Abareshi, 2012), (Murugesan, 2008), (Ruth, 2011)
Cloud Computing	Transferring applications to specialized providers	(Bachour & Chasteen, 2010), (Carlos Jr et al. 2013), (Ruth, 2011)
Equipment which increases PUE (Power Usage Effectiveness)	Using servers with higher energy efficiency	(Brill, 2007), (Epa, 2007), (Ruth, 2011)
Thin client	Low power computing and low power consumption terminals ("dumb terminals").	(Bachour & Chasteen, 2010), (Murugesan, 2008)
Terminal Server	Permission to access applications in different networks and reduction of dedicated terminals	(Appasami & Suresh, 2011)
Personal Computers (PCs) with energy saving technology	Automatic shutdown of monitors and CPUs (Central Processing Unit)	(Appasami & Suresh, 2011), (Bachour and Chasteen, 2010), (Murugesan, 2008), (Ruth, 2011)
Screen Savers	Reduced power consumption by monitors and CPUs	(Murugesan, 2008)
Us of multi-functions/multi-tasks	Reduction of energy consumption by the concentration of equipment	(Appasami & Suresh, 2011)
Energy seal	Use of equipment with proven energy consumption reduction	(Appasami & Suresh, 2011)
Toxic material reduction	Compliance with legislation such as ROHS (Reduction of Hazardous Substances in Electrical and Electronic Equipment)	(Molla & Abareshi, 2012), (Murugesan, 2008)
Equipment re-usage	Not disposing of equipment if it can be reused or donated	(Murugesan, 2008)
Equipment retrofit and update	Evaluating the possibility of replacing or reconditioning parts to increase the useful life of equipment	(Murugesan, 2008)
Re-cycling	Disposal in an environmentally sound manner	(Murugesan, 2008)
VoIP Telephony	Use of the same network and fewer devices	Mentioned in the pilot research

Source: Prepared by the authors

Method

Considering the characteristics of this study and the research question, the multiple case study method was chosen, characterized by a qualitative approach. According to Eisenhardt (1989), this method is appropriate in new fields of study, and the resulting theory is normally singular, proven by

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tests and empirically validated. The choice of method, according to Yin (2010, p.24), "allows researchers to retain the holistic and meaningful characteristics of real-life events."

This study evaluated cases related to the IT areas of companies engaged in sustainable development and their actions when selecting their IT projects. We understand that a company is effectively engaged in sustainable development when, in addition to claiming this engagement, it creates verifiable conditions and elements. During the selection process, companies included in the portfolio of sustainable stock indexes were considered, such as the Dow Jones Sustainability Index (DJSI) in the USA and the BM & FBOVESPA Índice de Sustentabilidade Empresarial – ISE (Corporate Sustainability Index) in Brazil.

From a universe of 2,500 companies, the DJSI index seeks to identify companies capable of succeeding in highly competitive environments characterized by changing business scenarios, managing the pillars of the Triple Bottom Line (Robecosam & S & P Dow Jones Indices, 2013). In Brazil, the ISE was created by the BM & FBOVESPA, in partnership with the Centre for Sustainability Studies of the Getulio Vargas Foundation (GVces), responsible for the technical consistency of the index (Marcondes & Bacarji, 2010). The ISE is also based on the Triple Bottom Line proposed by Elkington (2001) and, complementing the classical dimensions (economic, social and environmental), it includes in its composition the dimensions of corporate governance, climate change, product nature and general nature (GVces, 2013).

To broaden the research landscape, organisations from different sectors and diverse origins were purposely sought. Table 3 shows the organisations selected for this study. Some of the companies did not allow to have their data disclosed, and they will be mentioned as Company "n", being "n" number of study case.

Table 3
List of cases in the research universe.

Case study	Name	Origin	Sector	Index
Case 1	Company 1	Brazil	Metals	ISE
Case 2	Johnson Controls	USA	Automation / HVAC	DJSI
Case 3	Company 3	European	Industrial products	DJSI
Case 4	Company 4	European	Information Technology	DJSI
Case 5	AES Eletropaulo	USA	Power distribution	ISE
Case 6	CCR	Brazil	Transportation	ISE

Source: Prepared by the authors.

Case studies typically combine multiple methods of data collection (Eisenhardt, 1989). In this paper, we used sources of evaluation of company documentation and interviews with company representatives and compare results with the bibliographic research. In the research on company documentation, sustainability reports and results of the questionnaires presented for the sustainability index evaluations (DJSI or ISE) were used as theoretical validation of the companies' engagement in sustainable practices.

For the interviews, a flexible research instrument was used, which allowed us to include questions for the interviewees to clarify dubious points. We interviewed people responsible for the portfolio selection of IT projects and those responsible for sustainability, where it exists.

The interview script was composed of three parts. The first part being the research form, intended to characterize the interviewee's qualifications, his/her exposure in the company and specify the conditions in which the interview was conducted with the two aforementioned professionals.

The second part of the research form was made up of open questions to evaluate the professional's knowledge of the company's actions develops in sustainable development and portfolio management. This second part of the interview had two objectives. First one was to assess the degree of knowledge of the professionals about the sustainability approach of the company and assure that this is not just an advertising issue inside the company. Second objective was to collect their knowledge about how projects were selected and criteria for this process.

The third part of the research form was given only to the person in charge of selecting the IT project portfolio, asking this professional to analyse a list of Green IT criteria and indicate whether the criterion was considered and/or implemented. IT professionals were asked not only to answer yes or not, but also to justify their choice, including the main trend for the use of the criteria (cost reduction, performance, sustainability). At the end of the interview with the IT professionals, we presented printed labels with the Green IT criteria and asked the interviewees to sort them in order of importance. The objective of this evaluation was to check whether these professionals consider some criteria to be more important when selecting IT infrastructure projects.

To ensure that the interview script avoided ambiguities and followed an appropriate sequence, we conducted a pilot study in a multinational company of electric sector. Inputs collected during this

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pilot were used to adjust the questions of the research instrument.

In Case Study 1, the IT manager was interviewed. He had a degree in Data Processing, had worked for the company for 27 years and been in his current role for ten years. The object of Case Study 2 was the IT area of Johnson Controls, in the Building Efficiency division. The IT manager was interviewed. She had a degree in Business Administration and had been working for the company for 12 years and been responsible for the IT area of the company in Brazil for five years. In the companies of Cases 1 and 2, there was no one responsible for sustainability.

Two people were interviewed for Case Study 3: the sustainability manager and the IT infrastructure manager. The former was responsible for the Sustainability Office, with a degree in Business Administration and a master's degree in sustainability. He had been with the company for nine years and in his current position for two years since the creation of the area in Brazil. The IT Infrastructure manager was a mathematician, who had worked at the company for 35 years, always in the IT field, having held the current position for two years. For Case Study 4, we interviewed the consulting director 4, who worked with clients in the sale of solutions to support sustainability actions and was in charge of the organisation's internal IT area. The consulting director was an electrical engineer, who had worked in the Telecommunications area for eight years then moved to the IT area as a marketing manager. Since 2011, he had been working as a consulting director. The Chief Information Officer (CIO) had a degree in journalism and a master's degree in computer networks. He had been with the company for 13 years, having occupied his position for two years.

AES Eletropaulo is the object of study in Case 5. The interviewees were the Sustainability Specialist, with a background in Biology and a PhD in Nuclear Technology. He had been in the electric sector since 2006 and in the group for two years, always in the area of sustainability. The second interviewee in Case 5 was the IT Infrastructure Manager, a civil engineer, who graduated in 1977 and had been in the organisation for 12 years, always in the same role. The object of study in Case 6 was CCR. The Director of Communication and Sustainability was interviewed. He had a degree in Architecture and been in his position for 12 years. He was also responsible for publishing the group's sustainability report. The other respondent in Case 6 was an employee of CCR EngelogTec, with a degree in computer engineering. He had been with the group for ten years and in this position for a year.

According to Eisenhardt (1989, p.08), data analysis "is the heart of building theory from case-

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studies". With data obtained from environmental research and interviews, we used the steps of data reduction, data presentation and conclusion/checking technique (Gil, 2012). In the step of data reduction, we have put together data of the companies, profile of interviewers, description of main sustainability processes undertaken by the companies, and summarized the answers about the third part of the interview. Data presentation step sought to compare data previously analysed with three main focuses: validate whether the criteria (the ones mentioned in the Tables 1 and 2) was used or not at their organisation, perform a ranking of selecting projects criteria and check with the interviewers the driver for the criteria (cost reduction, performance and sustainability). Third step, conclusion/checking, was performed considering not only the answers yes or not, but also taking into consideration comments performed by interviewers. One example of this is related to the criteria Cloud Computing, which was not used by five of the six companies, however it was considered among the most important ones and a trend in the future.

Results and Discussions

As per the first step of the data analysis, an overview of the companies' profiles were performed. Characteristics that we investigated were related to the function that the IT area exercises in the organisation and definitions of the outsourcing of Data Centre services and management of user assets. A summary of characteristics of the companies in question is shown in Table 4.

Table 4
Characteristics of the cases surveyed in relation to IT.

Case	Data Centre	Management of user assets (Personal computers)	IT Function
1	Outsourced	Hybrid	Support the business
2	Own (small size)	Own	Support the business
3	Outsourced	Own	Support the business
4	Own (large size)	Own	Main business
5	Outsourced	Outsourced	Support the business
6	Own (medium size)	Own	Hybrid

Source: Prepared by the authors from the interviews with the IT managers of the companies

First analysis was done according to the interviewer's answers about application of each criteria to their process of project portfolio selection. Results are presented at Table 5.

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As it could be checked, some of the answers were affected by the companies' profiles. Analysing the set of responses of each organisation, we verified that factors such as a function of the IT area and outsourcing strategy influence the classification of whether to use a certain criterion of Green IT in the selection of projects. Companies that outsource their Data Centre operation are no longer concerned about the energy efficiency of the equipment installed there. However, for companies that have their own data centres, this is a constant concern. Despite this, we did not see differences due to the size of the data centres. In other words, the concern is the same for a large or small Data Centre.

Outsourcing still influences behaviour regarding Green IT criteria applied to user equipment, usually notebooks and desktops. Despite the lower technical complexity and lower power consumption compared with servers and data storage equipment installed in the Data Centres, their quantities are much larger, making management and governance more complex, and distributing energy consumption across multiple locations.

In our research, we verified three functions of the IT area. These can be to support the business, the final business or even a combination of the two, in a hybrid model. This distinction affects the behavioural model of companies regarding some Green IT criteria. While IT was not the ultimate business of four companies, Case 4 is a provider of IT solutions. At this company, striving for competitiveness to offer better solutions at costs compatible with the market forces the company to seek measures that are not on the radar of companies that outsource part of their services or come only for their own use. This scenario is similar to Case 6, an internal service provider for other companies in the group. The pressure for better solutions and cost platform imposed by the group of companies is intense, with the difference being that the discussions are conducted in a closed environment.

Table 5
Use of Green IT criteria in the selection of an IT project portfolio

Criteria	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Telework	No	Yes	Yes	Yes	Yes	Yes
Telepresence	Yes	Yes	Yes	Yes	Yes	Yes
Dematerialization	Yes	Yes	Yes	Yes	Yes	Yes
Server virtualization	No	Yes	Yes	Yes	Yes	Yes
Cloud Computing	No	Yes	No	Yes	No	Yes
Usage of multi-function /multi-task	Yes	Yes	Yes	Yes	Yes	Yes
Equipment which increase PUE	No	Yes	No	Yes	No	No
PCs with energy saving technology	No	Yes	Yes	Yes	No	Yes
Terminal Server	No	Yes	Yes	Yes	No	Yes

Thin Client	Yes	No	No	No	No	No
Screen Savers	No	No	No	No	No	No
Energy seal	No	No	No	Yes	No	No
Toxic material reduction	No	No	No	Yes	No	No
Equipment re-usage	Yes	Yes	Yes	No	No	Yes
Equipment retrofit and update	Yes	Yes	Yes	Yes	Yes	No
Re-cycling	No	Yes	Yes	No	No	Yes
VoIP Telephony	Yes	Yes	Yes	Yes	Yes	Yes
Tablets and Smartphones	No	No	Yes	Yes	Yes	Yes

Source: Prepared by the authors from the interviews with the IT managers of the companies

The results of the individual evaluation of the Green IT criteria allowed us to outline the scenario of how these are used in the selection of IT projects. Going beyond the yes/no answer and considering the comments of each interviewer (presented at Tables 7, 8 and 9), we were able to realise that these criteria might be classified into three categories: validated, not validated by limited application and not validated by obsolescence. Results of these analysis are presented at Table 6, including the ranking of the importance of criteria in the evaluation of a project portfolio. In order to obtain this ranking, it was considered the average of all interviewers' classification of criteria importance. Based on this ranking, server virtualization is considered the most important criterion when selecting project portfolio while possibility of retrofit and update current equipment was considered the last in a scale of importance.

Of the eighteen Green IT criteria evaluated in the specific literature, after an evaluation of the responses and comments of the organisations' IT managers, ten were considered validated as capable of distinguishing projects in their selection phase. A criterion was considered as validated when cited by the interviewees as being relevant in the technical evaluation phase of the portfolio selection and these ones are presented at Table 7. The opposite represents a criterion not validated by being considered of limited application (presented at Table 8). The last category was applied to the ones which were considered obsolete due to the advance of technology applied (presented at Table 8). A clear example of the obsolete criterion was the screen savers, which was replaced by a technology of power reduction.

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Table 6
Portfolio analysis characteristics and criteria.

Criteria	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Average	Validated	Obsolete
Server virtualization	4	1	1	6	4	2	3,0	Yes	No
Telepresence	1	7	4	5	2	8	4,5	Yes	No
Cloud Computing	3	2	3	10	9	3	5,0	Yes	No
VoIP Telephony	5	6	6	8	1	6	5,3	Yes	No
Dematerialization	6	3	5	7	6	9	6,0	Yes	No
Usage of smartphones and tablets	2	4	7	9	5	13	6,7	Yes	No
Telework	9	5	8	12	3	7	7,3	Yes	No
Equipment which increase PUE	11	10	15	1	10	4	8,5	No	No
Usage of multi-function /multi-task	7	9	9	14	7	10	9,3	No	No
PCs with energy saving technology	12	11	14	3	15	5	10,0	No	Yes
Energy seal	10	13	13	2	13	11	10,3	No	Yes
Terminal Server	14	14	2	11	8	14	10,5	No	No
Re-cycling	17	8	11	15	14	1	11,0	No	No
Toxic material reduction	13	12	18	4	18	12	12,8	No	Yes
Thin Client	8	17	17	13	11	15	13,5	Yes	No
Equipment re-usage	15	15	10	16	17	16	14,8	Yes	No
Equipment retrofit and update	16	16	12	17	16	17	15,7	Yes	No
Screen Savers	18	18	16	18	12	18	16,7	No	Yes

Source: Prepared by the authors.

Table 7
Validated Green IT criteria.

Criteria	Comments
Server virtualization	For the cases in which the organisation uses its own Data Centre, virtualization is a key criterion for reducing energy, space and air conditioning costs. For the cases using outsourcing, the criterion was only disregarded by Company 1, which pointed out that the decision is exclusive to the service provider. Another two cases considered that virtualization should be used whenever possible. We confirmed the findings of authors Appasami and Suresh (2011), Bachour and Chasteen, (2010), Molla and Abaresh, (2012), Murugesan, (2008), and Ruth, (2011), that virtualization is a Green IT criterion and is widely used.

Table 7
Validated Green IT criteria.

Criteria	Comments
Telepresence	This is one of four criteria used by all the companies. The cost was considered an important factor for its use, although employee comfort was considered equally important. The examples cited ranged from solutions that only act with voice and screen sharing to those that feature high definition monitors and a simulation of meeting tables. Company A mentioned that there is an official internal regulation that emphasizes the use of telepresence in order to avoid costs with business travels.
Cloud Computing	This criterion is one of the most controversial, and only Case 6 indicated that it had a signed contract to use a cloud network from an external provider. The company in Case 4, being the provider of this solution, uses its own platform. Safety was identified by the interviewees in Cases 1, 3 and 5 as a factor that prevents their use. Johnson Controls' IT manager said she did not check for security issues to use a non-private cloud. Despite the restrictions, it was considered as the third most important criterion, considering the average indicated by the IT managers, and may represent a future trend. The result obtained in this study confirms Bachour and Chasteen (2010), Carlos Jr, et al. (2013) and Ruth (2011).
VoIP Telephony	This criterion verified during the pilot research was unanimously used and considered as a decision criterion for project selection. Unanimity around this criterion and the evolution of networks may make it an obsolete criterion for project selection in a short time because, according to the IT infrastructure manager of Company 3, "soon not being VoIP will no longer be an option".
Dematerialization	Another criterion used by all the companies. It was initially considered as a corporate project, but projects were also cited that favour the electronic approval of processes without requiring signatures on printed documents. Campaigns to reduce printed waste were also cited, with applications that require passwords typed into the printer.
Usage of smartphones and tablets	Considered on average the sixth most important criterion in the answers of the IT managers of the organisations surveyed, the use of smartphones was quoted almost unanimously. The use of the tablet was cited as a study in only one case, but in two cases companies encourage their employees to use their personal equipment in the model known as BYOD (Bring Your Own Device).
Telework	With the exception of Case 1, this criterion is used in the selection of projects and is implemented in all the other companies. Platforms and applications that allow remote access are preferred to those that require the employee to connect locally through the organisation's corporate network. The company in Case 1, due to a human resources directive, does not employ this criterion, although the organisation has the technological capacity to use it.
Thin Client	Only the company in Case Study 1 cited using dumb terminals, but it does so because of security and cost issues. This positioning is in line with Bachour and Chasteen (2010) and Murugesan (2008), who consider the low cost of the hardware and low energy consumption as a characteristic of this criterion. In two cases, it was mentioned that studies are being conducted for the possible adoption of Thin Clients.
Equipment re-usage	Only the company in Case Study 4 claimed that it does not reuse equipment, but it does not know whether other subsidiaries around the world reuse equipment. This action is practiced in all the other cases, and only Case 5 indicated that it does not take this criterion into account when evaluating projects. Proposed as a criterion by Murugesan (2008), it can be considered a criterion that distinguishes projects, taking advantage of unused installed capacity.
Equipment retrofit and update	The IT company interviewee in Case 6 indicated that in their assessment, the desired benefit is not offset by the cost incurred. In all other cases, it was mentioned that this criterion was used in recent software updates¸ in which PCs that were still in their life cycle had the capacity of their memory cards increased to allow this update.

Source: Prepared by the authors

According to the comments of interviewers, we were able to realise that a set of criteria also collected in the specialized literature had a limited application. They are usually deployed as corporate projects, but afterwards no longer fit the criteria that distinguish candidates for IT projects. Their mention in the literature review considers a movement to make the existing infrastructure more sustainable, characterizing them as a unique effect. Table 8 presents the criteria that are considered not validated by limited application.

Table 8
Green IT criteria not validated due to limited application.

Criteria	Comments
Equipment which increase PUE	According to the interviewee responsible for the internal IT area of Company 4, which is a provider of Data Centre services, increasing the PUE is a fundamental need to maintain the competitiveness of the business. The interviewee from Case 2, who uses her own Data Centre, also stressed the importance of increasing the energy efficiency of the installed servers. CCR's IT infrastructure manager, who also manages his own Data Centre, said he was unaware of the term as it acquired first-line equipment that already incorporates energy-efficient technologies. It was not considered a criterion for project selection but was treated as an object of a corporate project, as proposed by Brill (2007) and the US Environmental Protection Agency (EPA, 2007) to minimize the impact of Data Centres in the energy matrix of countries.
Usage of multi-function /multi-task	Another criterion used by all. It has been restricted to multifunction printers but confirms the quote from Appasami and Suresh (2011) as a factor of sustainability. However, no evidence was found that this criterion can distinguish projects. Based on the considerations of the IT respondents, multifunction printers were deployed as technology evolved and as a corporate project.
Terminal Server	It was mentioned as being used when necessary to interconnect different networks, as suggested by Appasami and Suresh (2011). In the analyses of the case studies, it was considered a technical resource that is already incorporated into day-to-day operations, without the possibility of considering it a differential for project selection.
Re-cycling	All the cases studied, with the exception of one, stated that they have a process to dispose of equipment, either by returning to the supplier or making donations. The exception uses outsourcing and returns the equipment to the asset owner. Although this could be a criterion of sustainability, it cannot be considered as an element of project decision since all equipment must follow recycling or disposal procedures.

Source: Prepared by the authors

The last group of criteria evaluated are those considered to be obsolete or have already been incorporated into most of the available equipment. IT evolution is intense and constant, rendering products that were once valuable expendable. These criteria are set out in Table 9.

Table 9

Green IT criteria not validated due to obsolescence.

Criteria	Comments
PCs with energy saving technology, Energy seal and Toxic material reduction	Considering the cases analysed, all the companies stated that they acquire first-line equipment and that it already has these characteristics. It was considered much more a criterion for the purchase or specification of equipment. They cannot be considered as a differential to decide on projects, since they are intended for users, regardless of the type of application they will support or the project to which they will be allocated.
Screen Savers	Universally not considered a project selection criterion. It was considered a simple security element and obsolete in newer equipment.

Source: Prepared by the authors.

The order of importance determined by the interviewees of the IT areas demonstrated the personal opinion of these professionals regarding the criteria of sustainability, highlighted by the corporate vision of the organisation. Thus, some criteria were considered to be in a prominent position in order of importance, although not considered in the corporate analysis. The case of cloud computing using non-private networks may be cited. Although it was considered in only one case, it came third in order of importance. In this case, the respondents pointed out that the tendency to use networks in clouds that do not belong to the corporation is likely to grow in the future once security issues have been resolved.

In our research, when asking the interviewers if they considered the criteria as a factor for sustainability, we realise that, most of the times, interviewers did not recognize this, but rather as a factor of cost reduction or performance improvement. We understand that these drivers of cost and performance supplant the sustainability driver. Pressure to reduce costs and monitor performance was part of the routine of IT managers than a drive for sustainability, as predicted by Molla and Abareshi (2012), Murugesan (2008) and Nidumolu et al. (2009).

Conclusion

Contribution of this work to the theory is to make clear that besides sustainability is one of the most mentioned words in the business management area, at least in the selection of IT projects it is not the first driver to be considered, being considered after cost reduction and performance. However, it also became clear that IT Industry (mainly products) have been addressing sustainability concepts into their products which contributes to a tripod of cost-saving, higher performance, and yet sustainable approach.

As a contribution for the practice, the aim of this work is to consolidate and propose sustainable criteria for future portfolio evaluations of IT infrastructure projects. Taking into consideration bibliographic research and information collected during the interviews, practitioners of portfolio management, CIOs and other professionals of IT can use the ten criteria validated and effectively capable of distinguishing projects when facing the process of defining which of these projects will move on and which will be waiting or be dismissed.

A positive aspect is that IT development technology already incorporates in its portfolio of products and solutions some Green IT criteria identified in the literature. Thus, these criteria are used in project solutions, but almost unnoticed. They are viewed as obsolete, not because they are no longer used, but because they no longer need to be considered in analyses, as they are already part of the routine.

A limitation of this study is that it only included companies committed to sustainable development and included in the DJSI and ISE indices. The organisations are considered big companies, with structured IT areas and acting under principles of corporate governance. Small and medium sized organisations were not evaluated for the purpose of comparison. In this sense, companies that are not included in sustainability indexes like the DJSI or ISE could be included in future studies, comparing these two "categories" of organisation.

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