GREEN INFORMATION SYSTEMS ADOPTION: A REFLECTION ABOUT META-THEORETICAL ASSUMPTIONS TOWARDS A RESEARCH AGENDA

ABSTRACT

This paper aims to propose a paradigmatic reflection for GIS adoption studies from the four meta-theoretical assumptions: ontological, epistemological, human nature and methodological. This study is stimulated by some research concerns related to the philosophical assumptions of the GIS adoption studies in which has been few explored in the literature. It has faced ontological concerns about the origin of basic concepts that surrounds the field. The traditional IT adoption field has influenced the nature of this GIS studies in terms of using of theories and methods. It makes difficult the understanding about the essence of the phenomenon and its reality. We discussed four research questions related to the meta-theoretical assumptions. To do so, we performed a literature review based on descriptive review analysis through Atlas.ti software. To present a comprehensive and transparent systematic process, we explored the standards of trustworthiness of literature review. Analysis determined the extent to which the body of empirical studies of the GIS adoption field supports patterns/trends with respect to meta-theoretical assumptions. Our findings revels that GIS adoption field supports the functionalist paradigm derived from the IT adoption studies, adopting assumptions guided towards an objective nature approach: realism, positivism, determinism and nomothetic. This mainstream contradicts the nature and proposal of the GIS field. Due to the complex nature of the relation of the phenomenon, this paper suggest a "paradigmatic rupture" of the area to seek explanations of individual consciousness and subjectivity that allows the adoption of the interpretative paradigm involving nominalism, anti-positivism, voluntarism and ideographic assumptions.

Key words: IT adoption; GIS adoption; Adoption theories; Meta-theoretical assumptions

INTRODUCTION

The increasing scarcity of natural resources, the accelerating pollution of the environment, and the looming threat of global climate change have attracted the interest of information systems (IS) scholars. The rapid diffusion of technology, these discussions were incorporated to the IS discipline under two points of view: information technology (IT) as part of the environmental problem, and information systems (IS) as solution for the environmental concerns. Thus, the relation between IT and natural environment has been the core of the discussion in order to address the public concerns such as pollution, environmental awareness and business strategies for sustainability (Dedrick, 2010; Hanne, 2011).

Despite the relevance of this theme, the debate surround of this complex relationship is still scarce in the IS community, especially when it involves organisational settings (e.g., Melville, 2010; Gholami et al., 2013). From this discussion, the subject about green information systems (GIS) emerges as one of the most important concerns in organisations which its purpose is the development and the use of information system to support environmentally sustainable initiatives (Molla et al., 2009; Ryoo and Koo, 2013).

Specifically, one of the researcher concerns of the GIS field is to understand "what leads an organisation to adopt green information technology solutions?" since that organisations are still in initial stage of consciousness of adoption of this initiatives (Gholami et al., 2013; Jenkin et al., 2011). It seems to represent the initial concern of the traditional IT adoption field when Davis (1986) developed the technology acceptance model.

Although the production of the GIS studies has grown since 2009, there have been few studies evaluating empirically the GIS adoption in the organisational settings. We believe that one of barriers is to consider the distinct area of GIS since it covers an interdisciplinary area that includes the complexity of the environmental sustainability issues and demand different philosophical, methodological perspectives and theories (Melville, 2010). Thus, this current study is stimulated by some research concerns related to the nature of the GIS adoption studies that involves philosophical assumptions about ontology, epistemology, human nature, and methodology issues.

First, the GIS studies still face ontological concerns about the origin of basic concepts that surrounds the field. For example, the lack of consensus and the variety of concepts and terminologies to define the term or the concept of green technology (e.g.: Cai et al., 2003) can make difficult the understanding about the essence of the phenomenon and its reality. Second, we believe that the IT adoption field has influenced the nature of this GIS studies in terms of formulation of research questions, use of same theories to explain the technology adoption, and use of deterministic research methods to analyze the phenomena. The IT adoption field is a mature body of knowledge and represents the study of the IT artifacts and individual's behavior that are investigated into the epistemological positivist perspective. It has been criticized due to the accumulation of knowledge, without presenting substantive theoretical progress and creating continuous replication and small extensions of theories and models (e.g., Benbasat and Barki, 2007; Venkatesh et al., 2007). This reality indicates that the replication of meta-theoretical issues in the GIS adoption studies can represents a limited progress of the area.

Despite the specific propose of GIS adoption field (e.g., including complex and broad aspects of environment, requires balance of socio-economic goals), the functionalist approach of the IT adoption field seems to extend to the GIS adoption studies in which the individuals respond extern stimuli that determinate behavior for adoption (Molla, 2009). Furthermore, this perspective will influence a methodological choice of the researcher; this is, as much as functionalist and

structural is the view of the GIS adoption phenomenon, more quantitative techniques can be used by the IS scholars (Burrel and Morgan, 2979).

Since that GIS studies propose an analysis complex between technology, individuals and natural environment, the functionalist approach may compromise the development of the area and discourage scientific progress in the GIS adoption field. However, the challenge is to identify the paths to be followed and the theories to be used to embrace in an appropriate way the subjectivity of the phenomenon (Melville, 2010). The motivation of this study is based on a reflection about if the progress of the GIS adoption field is influenced by traditional IT adoption studies and if it is worth to put forward discussions about GIS adoption issues.

We believe that to investigate the nature of the GIS adoption phenomenon can represent an opportunity for further advances in the IT adoption field. Additionally, it can explain part of the concerns about the lack of engagement of the IS scholars in the GIS field (Gholami et al., 2016). Our paper proposes a paradigmatic reflection for the GIS adoption phenomenon based on the four meta-theoretical assumptions by Burrel and Morgan (1979): ontological, epistemological, human nature and methodological. We elaborate a research agenda consisting of four research questions that can be explored for further studies. This debate will provide a clearer understanding around the nature of the GIS adoption field.

Next sections of this are organized as following way. Section Background provides a discussion about the natural environment in organisation settings, concepts of GIS, traditional IT adoption and GIS adoption theories and its differences, and appointments about meta-theoretical assumptions by Burrel and Morgan (1979) as well. Section Method highlights the research methods. Next Section presents discussions and research questions. Finally, Section Conclusions highlights suggestions for future researches, practical and theoretical contributions and research limitations.

BACKGROUND

Environment issues in organisations

The environmental damages has been manifested as a symptom of the civilization crisis, driven by the modernity and ruled by diffusion of technology and economic development. Since then, eco-development strategies has been created to generate new models of production and lifestyles as an alternative to unequal exchange model and capital accumulation. One of the strategies is related to the practice of sustainable development initiated by United Nations in the late 1960s. It proposes a future for the world, integrating strategies of environmental protection, social equity, and economic development (Nolim, 2010).

In organisations, the perspective of the sustainability seems to absorb a reasonable logic of natural environment as a meaning of production and source of wealth. Often, the search for the eco-sustainable solution is a strategy to reduce costs and increase the profit. In this context, it is essential to identify the

goal of the sustainability to address questions such as "whose sustainability?" and "sustainability for whom?". To do so, it is necessary to have an understanding about the formation of the environmental knowledge, where does it come from and how is it communicated through the society. For example, Bone et al. (2011) emphasizes that the traditional environmental knowledge is characterized by the knowledge of a community and the way in which it is communicated through generations. It seems important to develop an ideology into the organisation around green practices, establishing a culture towards nature preservation.

The academic discussion (e.g., Melville, 2010; Watson et al., 2010) has frequently focused on the understanding of the relation between IT and environmental sustainability for two reasons. First, organisations have great potential contributing to the degradation of nature, since they have large capacity to produce innovations and changes (Elliot, 2011). Second, part of the innovation process is related to the diffusion of the technology supporting work processes. It occurs because the information systems are considered the most important resource for improving the productivity of the organisations (Watson et al., 2010).

Green information systems

The term "green" was originally incorporated by IT practitioners to differentiate IT artifacts designed to support environmental sustainability practices (Park and Jeong, 2014; Buttler, 2011). However, the need to disseminate and implement green initiatives in organisations has stimulated IS scholars to associate the term "green" with the IT as well as incorporating concepts such as companies, systems, products and production processes. Due to this complex association, there is a variety of terminologies in the literature trying to define IT and organisation in terms of "green". Cai et al. (2013) argue that the terminologies used are varied (e.g., IT for environmental sustainability, green IT, green IS, IT for green, green computing) and treated differently, depending on how the IT is seen as a problem or a solution.

When IT is seen as a problem, the term "Green IT" has been used when the environmental impact is caused by the use of IT at level of hardware and software (Park and Jeong, 2014). In IT as a solution, the term "Green IS" has been used when the use of IS supports business initiatives aiming to reduce negative impacts on the environment (Park and Jeong, 2014). The difference of theses terminologies comes from the concept of the terms IT and IS. IT refers to technologies of hardware and software in which capture and process information and IS represents the combination of IT, people, processes, individual advances, groups, and business goals (Molla, 2013). In order to standardize terms, our study adopts the term green information system (GIS) in which refers to the use of IS that supports business initiatives to reduce negative impacts on the natural environment.

There are evidences that GIS can bring organisational benefits, such as: energy saving, recycling and reuse of material, reducing of cost, pollution and water consumption, and preservation of natural resources (Park and Jeong, 2014; Chou

and Chou, 2012). Despite these benefits, organisations have faced doubts and challenges into the adoption process because the implementation of GIS seems not be economically viable (Lei and Ngai, 2012; Molla et al., 2009).

These uncertainties may be associated with several factors such as the difficulty of the organisations to understand and implement the wide concept of sustainability by Brundtland (Dao et al., 2011; Unhelkar, 2011). According to Melville (2010), the concept of sustainability is complex, multilayered and characterized by uncertain and nonlinear interdependencies for involving economic, social, and environmental issues. Thus, the fundamental principle for an effective implementation of sustainable initiatives is to pursue strategies that balance these three issues in which Dao et al. (2011) outline as three pillars of the triple bottom line framework.

Nevertheless, Bengtsson and Àgerfalk (2011) point out these issues are not frequently discussed in the IS and environmental sustainable studies. Wang et al. (2015) show that the researchers do not pay equal attention to these elements, for example, the discussion of social results is still scarce in the literature. Most studies focus on environmental or economic results, revealing a lack of empirical research that incorporates the integration of the three factors. In the IS field, the economics aspects represent common theme among the studies, but do not appear aligned with the Brundtland's report intentions (Bengtsson & Àgerfalk, 2011).

Usually, the main point of view of the economic perspective represents a classic vision of organisational issues such as productivity and profitability (Bengtsson & Àgerfalk, 2011; Melville, 2010). Molla (2009) argues that the GIS adoption should have as the main consideration the IT potential to enable companies to achieve eco-friendly goals in favor of the natural environment. In the other hand, the social aspects are related to issues such as satisfaction and personal needs (ex.: fair market practices and human rights), also representing organisational issues (Melville, 2010). It also is connected to the environmental orientation, social behavior, and cultural developments in organisations (Schaltegger et al., 2003). Although, the social considerations are occasionally mentioned, revealing the lack of studies that explore this area (Wang et al., 2015).

Finally, the environmental issues are discussed in the IS studies focusing mostly on technical issues of the energy such as computers with efficient energy, energy in data centers, server virtualization, aspects of hardware life cycle affecting the ecological footprint, among others (Bengtsson and Àgerfalk, 2011). In environmental considerations is necessary to pay more attention to issues that include natural resource preservation and climate changes mitigation (Melville, 2010).

Technology adoption and theories

Studies about technology adoption have inspired over 26 years the development of theories to explain individual's behavior towards technologies (Figure 1). This area was driven by the Davis in 1986 when developed the technology acceptance model (TAM). According to Venkatesh et al. (2007), TAM is an

adaptation of social psychology because it uses the relationship between the attitude and intention constructs of the theory reasoned action (TRA) developed by Ajzen and Fishbein in 1980 and by Fishbein and Ajzen in 1975 (Venkatesh et al., 2007).
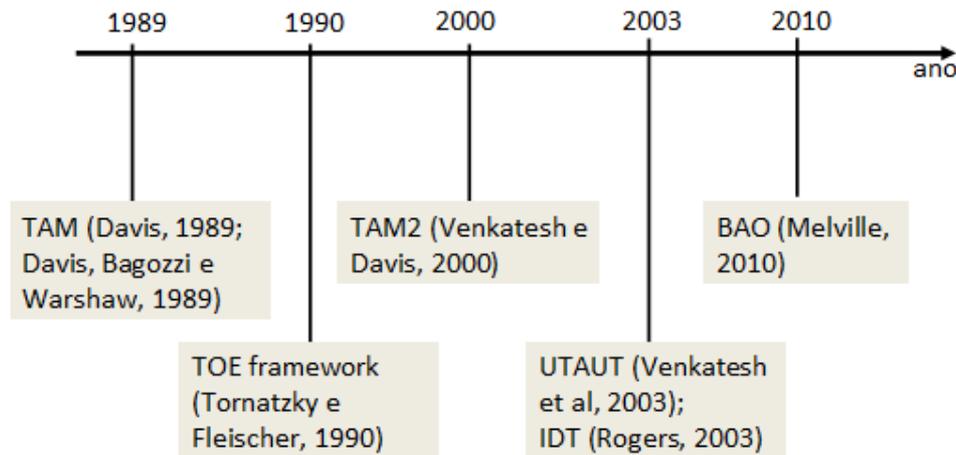

Figure 1: Main theories of technology adoption studies (IT and GIS adoption)

In 1990, Tornatzky and Fleischer built the technology-organisation-environment theory (TOE framework) which establishes that the adoption and implementation of technological innovations are influenced by three elements interacting with one another to influence the adoption decisions: technology, organisation and environment (Bose and Luo, 2011).

Due to TAM limitations, Venkatesh and Davis (2000) developed the technology acceptance model extended (TAM2). The difference between the TAM2 and the original TAM is the presence of the subjective norm derived from TRA (Pavlou and Fygenson, 2006). Further, formulating unified view about IT acceptance research, Venkatesh et al. (2003) developed the unified theory of acceptance and use of technology (UTAUT) examining and integrating components of eight different models.

Next, innovation diffusion theory (IDT) has been modified since the original model published in 1962 (Rogers, 2003). The IDT was empirically tested and validated (e.g., He et al., 2006) but it seems to be limited because it does not offer generalized measures for its five attributes of the adoption process. The subjectivity of the concept of each attribute of Rogers (2003) makes difficult the development of accuracy measures. Although Moore and Benbasat (1991) and Compeau et al. (2007) have proposed the measures for IDT, these measures hardly can be generalized due to the specificity of the research object (e.g., kind of technology).

The most recent model which offers a distinct proposal to the GIS field was proposed by Melville in 2010. It suggests a conceptual framework denominated Belief-Action-Outcome (BAO). The BAO differential is related to the attempt of explain the complex relation between organisation, technology and natural environment to alert researchers of the IS area to renew the analysis tools and the adoption theories in the face of the specificity of the organisational context

that involves IT and environmental sustainability. BAO is based on the model of micro-macro relations suggested by Coleman in 1986. Melville (2010) integrates macro and micro environments involving the adoption phenomenon. Since then, few studies have explored this model, for example, Gholami et al. (2013) proposed an empirical study to test and validate the BAO model.

Among these theories, TAM is still considered the most influent and the most used in researches addressing research concerns about IT adoption. Despite the robustness and its influence, TAM presents limitations and weaknesses for disregard important factors (ex.: cultural and historical elements), providing a limited investigation of the wide range of consequences involving the IT adoption, hence its main constructs are treated as "black boxes" (Benbasat and Barki, 2007; Gefen and Straub, 2000; Goodhue, 2007; Lee et al., 2003).

However, to overcome the limitations of TAM, researches about IT adoption (e.g., Chen et al., 2009; Devolver et al., 2008) and GIS adoption (e.g., Koo and Chung, 2014; Koo et al., 2015) have unified theories and models seeking for wider results. Usually, this union involves theories with complementary or different epistemological origins. For example, Bose and Luo (2011) combined the TOE framework, the IDT and the Process-virtualization-theory. Koo and Chung (2014) joined the self-determination theory and TAM. Koo et al. (2015) used the motivation theory, the reference group theory the constructs of TAM.

In general, theories of the IS discipline have been quite extensively applied to the study user intentions and behavior of individuals. However, these theories are used to predict specific aspect of the user acceptance of the information technology rather than understanding the interaction and communication between technology, individual and natural environment (Oinas-Kukkonen and Harjumaa, 2009; Corbett, 2013). Due to this, it is unclear which models and theories are appropriate to analyze specific research questions towards the GIS (Melville, 2010). Molla (2009) argues that it is important to understand if the previous theories used to explain the IT adoption initiatives can be applied to GIS studies. From this point of view, this research supports the argument that there are differences between the IT adoption and GIS adoption phenomena, and its adoption processes should be treated in different perspectives.

Traditional IT adoption versus GIS adoption

The IT adoption mainstream points out that the adoption process depends on how people perceive the technology and how organisational factors might to support it as well. In this context, organizations undertake new technologies pursuing organizational performance paradigms. Most researchers investigate the IT adoption to explain how system usage affects performance at a single level (e.g., individual, group, and organisational) (Burton-Jones and Gallivan, 2007). On the other hand, the GIS adoption process goes beyond the system usage view, pursuing a sustainable development paradigm. For example, organisations have implementing these technologies to engage individuals and change their behavior to be more environmentally responsible (e.g., Corbett, 2013), improve the environmental performance (e.g., Hilty et al., 2006), and

develop strategies for wider environmental sustainability projects (e.g., Chowdhury, 2012a).

The traditional IT adoption tends to study the system usage at single level (Burton-Jones and Gallivan, 2007). However, whether the GIS studies consider a holistic view of the elements of the sustainable development, it seems reasonable to think its analysis based on multiple levels (e.g., individual, society, organization, and natural environment) to understand linkages and the effect of the technology on different levels of analysis.

Characteristics	Traditional IT adoption	GIS adoption
Paradigm	Organisational performance	Sustainable development
Level of analysis	Single level	Multiple levels
Aspects of adoption	System usage	Beliefs, actions, and outcomes

The level of analysis has influenced the way in which the adoption process has been investigated. In the traditional IT, the adoption process is based in two stages: 1) the primary adoption which represents a decision in company level to adopt the IT; and 2) the secondary adoption (after implementation) consisting of the user adoption in which represents the use stage (Gallivan, 2001). The primary adoption may be easier to be performed because the proposal of technology implementation promises immediate benefits such as increasing in efficiency and improvements of the organisational performance. Gallivan (2001) argues that the most discussed and critical stage is the system usage because the adoption decision can not be guaranteed by the users (individual level). In the GIS studies, the BAO framework' statements propose a view of the adoption process based on three aspects such as beliefs, actions, and outcomes. Its proposal offers a holistic view of the adoption phenomenon suggesting an analysis based on multiple levels (macro and micro aspects).

Nature of the GIS adoption studies and meta-theoretical assumptions

According to Burrel and Morgan (1979), social scientists have emphasized their topics through four implicit and explicit assumptions in relation to the "nature of the social world and the way in which it may be investigated". First, the ontology assumptions discuss about the essence of the phenomenon under investigation, questioning whether the "reality" is an external reality of the individual or a product of his/her conscience or cognition (Burrel and Morgan, 1979). It suggests thinking about the phenomenon, putting in question the self, the world, and the experience. The antagonism that involves the search for the truth will depend on the kind of ontological approach used by the scientist, either a subjective nominalist approach or an objective realistic approach (Burrel and Morgan, 1979).

The nominalist approach assumes that the external social world of the individual cognition is composed of names, concepts, and labels used to structure the reality. The names are artificial creations whose usefulness is based on its

convenience as a tool to describe, give sense, and negotiate with the external world. The realism postulates that the external social world of the individual cognition is a real world made with solid, tangible, and immutable structures. Whether or not they are perceived or named, the realists keep the argument that these structures exist as empirical entities.

Table 1. Set of assumptions regarding the nature of social science

Subjective Approach		Objective Approach
Nominalism	Ontology	Realism
• The social world external to individual cognition is composed and formed by names to structure the reality; • The names used are artificial creations whose utility is based upon their convenience as a tool to give sense to the external world.		• The social world external to individual cognition is a real world made up of hard, immutable, concrete and tangible structures; • The world exists independent of us as empirical entities; • The world exists independent of an appreciation of the individual; • It is not something which the individual creates – it exists out there.
Anti-positivism	Epistemology	Positivism
• Against the utility of a search for laws or underlying regularities in the world of social affairs; • Social world is relativistic and can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied; • Human activities can only be understood by reference of the participant in action; • Understanding from the inside rather than the outside.		• To explain and predict what happens in the social world, searching for regularities and causal relationships between elements; • Traditional approaches that dominates natural sciences, verifying and/or falsifying hypotheses; • The growth of knowledge is essentially a cumulative process in which new insights are added to the existing stock of knowledge and false hypotheses eliminated.
Voluntarism	Human Nature	Determinism
• Individual is completely autonomous and free-willed.		• See the individual and his activities as determined by the situation or the environment in which is located.
Ideographic	Methodology	Nomothetic
• Understand the social world by obtaining first-hand knowledge of the subject under investigation;		• Research based upon systematic protocol and technique; • Use of quantitative

• *Emphasis closer to the subjective of the people generated by "getting inside" situations;* • *Penetrates in people history of life, in daily routine, the detailed analysis of the insights revealed in impressionistic accounts found in diaries, biographies and journalistic records;* • *Let the subjective of the people reveals its nature and characteristic.*	*techniques for data analysis;* • *Hypothesis test and scientific rigor;* • *Use of methods applied in natural sciences;* • *Use of standardized instruments: surveys, quizzes, personality tests, standardized research instrument, etc.*

Second, epistemology nature assumptions mean the base of knowledge about how someone might begin the understanding of the world and how to communicate it to their fellow human beings (Burrel and Morgan, 1979). This assumption involves two extreme approaches: anti-positivism and positivism. Anti-positivist epistemology is firmly against the searching for laws or underlying regularities in the social world (Burrel and Morgan, 1979). From this view, the social world is essentially relativistic and may only be understood from the individuals' point of view directly involved in activities under investigation (Burrel and Morgan, 1979). In this case, the understanding of the human activities is seen from the participant in action. In the other hand, the term positivism characterizes epistemologies that seek to explain and prevent what happens in the social world searching regularities and casual relationships between its elements (Burrel and Morgan, 1979). It is based on a traditional emphasis in which regularities hypothesized can go through verifications or falsifications (Burrel and Morgan, 1979). Yet, positivism accepts that the knowledge is essentially a cumulative process in which new insights are added to create a stock of knowledge and eliminate false hypothesis (Burrel and Morgan, 1979).

The third assumption applies to the human nature. Burrel and Morgan (1979: p. 2) argue that all social science should be "predicated upon this type of assumption, since human life is essentially the subject and the object of the investigation". They also point out that some perspectives of the social science link "a view of human beings responding in a mechanical or determinist fashion to the situations encountered in their external world". Thus, individuals and their activities are seen as determined by the environment which they belongs.

The three assumptions described above imply directly on the methodological nature. The methodological assumption presents two extremes: ideographic and nomothetic approaches. Ideographic is based on the view that the social world may only be understood by obtaining first-hand knowledge of the subject of the investigation. This emphasis allows the subject unfold his/her nature and characteristics during the investigation process. Nomothetic emphasizes research based on protocols and systematic techniques, focusing on processes of hypothesis tests, and using quantitative techniques in the data analysis process.

Table 1 summarizes four assumptions regarding the nature of the social science and its respective approaches. The combination of these approaches characterizes a different paradigm. The set of assumptions such as realism, positivism, determinism, and nomothetic holds characteristics of functionalist paradigms. The nominalism, anti-positivism, voluntarism, and ideographic assumptions when taking together hold characteristics of interpretative paradigms (Burrel and Morgan, 1979). The understanding of the paradigms may provide a convenient way to find a personal structure of reference and understand "why certain theories and perspectives are more attractive than others" (Burrel and Morgan, 1979: p. 24). "Like any other map, it provides a tool to establish where you are, where you have been and where it is possible to go in the future" (Burrel and Morgan, 1979: p. 24).

METHOD

We performed a literature review based on descriptive review analysis. Considering Paré et al (2015)'s typology of literature review. Our research used a descriptive review to determine the extent to which the body of empirical studies of the GIS adoption supports or reveals patterns/trends with respect to meta-theoretical assumptions. Thus, we discussed the following research questions (RQ):

RQ1. How do IS scholars investigate the "reality" of the GIS adoption phenomenon?

RQ2. What the base of the GIS adoption's knowledge and how is it shared among the IS scholars?

RQ3. How does human's behavior respond to the natural environment issues?

RQ4. How have data analysis techniques been conducted by GIS adoption studies?

In order to present a comprehensive and transparent systematic process, we explored the standards of trustworthiness of literature review by Paré, Tate, Johnstone, and Kitsiou (2016). Paré's et al (2016) systematic process was chosen because it is the most recent proposal to improve the quality of the literature review in information systems discipline. Next, to outline the GIS literature, we used the Web of Science™ Core Collection (WoS) using the indexes Science Citation Index Expanded (SCI-EXPANDED) and Social Science Citation Index (SSCI). The WoS was preferred because it offers a rank top countries, journals, scientists, papers, and institutions by field of research (Bhardwaj, 2016).

We conducted the search process on May 31, 2016 using the following keywords combined through Boolean operators (AND, OR): "green IT adoption", "green IS adoption", "green IT/S adoption", "adoption of green IT", "adoption of green IS", covering all the years to rescue the historical progress of the area. In the search refining process, we included only publications defined as article published in English. The analysis dropped out publications defined as: proceedings paper, letter, editorial material, book review, book chapter, among others.

We founded only eight papers that make reference to the topic. Our inclusion criterion was adding empirical studies. Thus, just six papers were included in the analysis. Articles (e.g., Bose and Luo, 2011; Deng and Ji, 2015) located as literature review were dropped out. Considering the methods of analysis, we performed a semantic analysis to understand which theories IS scholars have used to investigate the GIS adoption phenomenon and what the nature of the theories based on Gregor (2006)'s concepts. We also analyzed the dominant characteristics of meta-theoretical assumptions based on Burrel and Morgan (1979). To do so, we performed a descriptive review using coding methods and categorizing the content into each meta-theoretical assumptions. The coding stage was performed in two following cycles: 1) descriptive coding and 2) focused coding (Saldaña, 2009). The analysis was performed through Atlas.ti software version 7.5.

DISCUSSIONS AND RESEARCH QUESTIONS

This section pretends to relate the meta-theoretical assumptions to the GIS adoption studies discussing the four research questions. We coded quotes to these assumptions across the papers (Table 2). The descriptive coding (1º cycling) resulted in a total of 101 quotes. Then, in the focused coding (2º cycling), it was reduced for a total of 94 quotes across the papers. Yet, it shows that the assumptions with highest number of quotes present characteristics of functionalist paradigms.

Table 2. Number of quotes for each assumption and its respective illustrative quotes

Meta-theoretical assumptions	Descriptive coding	Focused coding	Illustrative quotes
Nominalism	*3*	*4*	1.*"We aggregate the different Green IT policies into three groups according to the typologies proposed by..." (Bohas and Poussing, 2016)* 2.*"As an antecedent of an environmental sustainability orientation, ecological responsibility is considered 'a motivation that stems from the concern that a firm has for its social obligations and values'". (Koo et al., 2014)*
Anti-positivism	*1*	*2*	3.*"Given that rich qualitative data have been noted as a valuable way to examine construct relationships, as well as to conduct exploratory research of contemporary events without the need for strict research controls, it seemed appropriate to draw on in-depth interviews and web-content analysis to investigate the nascent topic of Green IT/S in organizations" (Jenkin et al., 2011)*

Voluntarism	*1*	*1*	4.*"Environmental issues emerged as part of CSR programs as anticipated, which enabled an assessment of the extent to which employees associate elements of Green IT/S with their organization's environmental management practices"* *(Jenkin et al., 2011)*
Ideographic	*4*	*3*	5.*The interviews, while guided by a general interview protocol, remained largely unstructured. As demonstrated in the interview protocol, employees were not probed for Green IT/S issues but asked general questions about CSR programs"* *(Jenkin et al., 2011)* 6.*"...we used NVIVO software [...] to code and analyze these environment-related segments of the transcripts..."(Jenkin et al., 2011)*
Realism	*12*	*15*	7.*"External regulation measures (i.e., perceived usefulness) were adapted fromTaylor and Todd (1995). Item measures for social influence and attitudes were adapted from Taylor and Todd (1995). Continuous intention to use Smart Green IT was adapted from Venkatesh et al. (2008)." (Koo and Chung, 2014)* 8.*"With respect to intermediate variables, items to measure green manufacturing coordination were adopted from Ryoo and Koo (2013)" (Koo et al., 2014)*
Positivism	*24*	*25*	9.*"Our empirical study shows that the relationship between economic factors and green IT or IT for green is largely consistent with our hypotheses" (Cai et al., 2013)* 10.*"There does not seem to be any significant difference between Strategic and responsive CSR on the probability to adopt SUBSTITUTE green IT." (Bohas and Poussing, 2016)*
Determinism	*16*	*6*	11.*"The BOA links the influence of social and organizational contexts on individuals' and organizations' beliefs and the influence of them on actions and subsequent outcome" (Gholami et al., 2013)*
Nomothetic	*40*	*38*	12.*"To analyze our data, we adopted a confirmatory approach using partial least squares (PLS) as our analysis method."*

			(Koo and Chung, 2014)
			13.*To test the conceptual model and associated hypotheses, we used a dataset generated from a survey questionnaire…"* *(Gholami et al., 2013)*

Source: Research data (2016)

Table 2 also shows some illustrative quotes coded for each meta-theoretical assumption. For example, the quote "1" represent the nominalism assumption because the typologies to name the Green IT policies holds that the social world external to individual cognition is composed and formed by names structuring the reality. The quote "9" holds a positivist characteristic because the paper searches for causal relationships between elements to explain and predict what happens in the social world.

Table 3 summarizes the characteristics of the meta-theoretical assumptions as well as the type of the theories used by the studies of GIS adoption. Next, these assumptions are discussed by the following research questions.

RQ 1: How do IS scholars investigate the "reality" of the GIS adoption phenomenon?

The studies of GIS adoption reflect an ontological nature into the objective realist approach. The realism applied to the adoption models does not consider the logic complexity involving the relation between IT, organization, and natural environment. For example, the TAM constructs used in the Koo and Chung's (2014) research assume that the reality observed is external to the individual. In this model, the technology characteristics (e.g., perceive ease of use) and individual's behavior (e.g., attitude around the GIS use) are based in a concrete pre-established structure, preventing the subject from think about the relationships of the events. The way these variables are treated, lead the subject to become non-thinking being, disregarding the idea that each individual can perceive different attributes of the technology and have a mutable behavior in different situations.

Due to the influence of theories of adoption, the trend of research in this area is to eliminate the subject of context to pay attention to the object of study. It means considering relations of predetermined constructs that are measured apart of the appreciation of the subject/researcher. In GIS adoption phenomenon, the subject needs to understand the subjective elements that involve the dynamic of the organisations, technology, and natural environment as well as the participation of the individual that carries different values, beliefs and ideologies around the object as well.

These subjective elements are hidden inside the "black boxes" of the models and adoption theories and its challenge is to understand how the adoption process happens when it intends to introduce GIS initiatives in organizations. Researchers should adopt a more subjective approach, based on an interpretative nominalist paradigm to understand holistically the phenomenon of GIS adoption, trying to avoid the existence of any "real" structure of the world. It means, it is important

to conduct studies from a perspective in which the main objective is not developing a theory to be testable in a strict sense (validity and credibility) but understanding the complex world from the researcher's point of view and experience (Gregor, 2006).

Table 3. Previous international researches about GIS adoption from 1989 to 2015

Authors/year	Theoretical Framework	Type of theory	Assumptions
1. Gholami et al. (2013)	Belief-Action-Outcome Framework	Predict or explain: theory as a statement of relationships between constructs that can be tested (leads to propositions that can be empirically tested)	**Ontology**: reality of objective nature. **Epistemology**: communicates the knowledge of immutable way through models and theories with pre-determined variables, using traditional research approaches. **Human Nature**: the activity of the individual is seen as determined by causal relationships between the variables **Methodology**: suggests propositions for testing and empirical validation, testing and validation of hypotheses, application survey and statistical tests.
2. Cai et al (2013)	Stakeholder Theory		
3. Koo and Chung (2014)	Self-Determination Theory and TAM		
4. Koo et al. (2015)	Theory of Motivation; Reference Group Theory e TAM		
5. Bohas and Poussing (2016)	Do not specify theory or model	Econometric model	
6. Jenkin et al. (2011)	Suggests a framework of the green IT/S research that involves motivational forces of sustainability, strategies and environmental orientation	Prescribe: theory as a statement that says how something should be done in practice.	**Ontology**: determines names for the constructs to structure reality and analysis in a subjective way. **Epistemology**: analyzes relationships between constructs in an exploratory way, without strict search controls. **Human Nature**: individual activity is seen within a process with greater autonomy when trying to capture the perceptions of users regarding the social responsibility programs.

			_Methodology__: use of research questions to guide the studies, conducting interviews._

RQ 2: What the base of the GIS adoption's knowledge and how is it shared among the IS scholars?

Considering the epistemological assumption, the studies assume a positivist position using models and theories that predict and explain the adoption process through the search of regularities within organisational, technological, and individual aspects. From this perspective, researches try to establish causal relationships between such aspects, including only facts belonging to the laws established by adoption theories. This immutable way to communicate the world is perceived in both traditional IT adoption studies (e.g., He et al. 2006; Titah and Barki, 2009), and GIS adoption studies (e.g., Gholami et al. 2013; Koo and Chung, 2014; Koo et al., 2015) as well.

Chen et al. (2009) tested a model of IT adoption integrating the Innovation Diffusion Theory (IDT) and the Technology Acceptance Model (TAM) from the relationship of the constructs treated through rigorous scientific procedures. In the GIS studies, Gholami et al. (2013) used BAO framework as a declaration of relationships between constructs from previous studies. It means that the individuals' action to undertake GIS initiatives is result of predefined variables.

Despite theories of adoption being derived from human and social sciences (psychology and sociology), researchers apply methods derived from natural sciences (positivist approach) to explain the social and human behavior involved in the adoption phenomenon. The choice of these methods is conflicting with the epistemological nature of the GIS adoption phenomenon which requires a more subjective understanding to explore the complexity of the ecological issues and its relation with the technology and society.

Despite the phenomenon of GIS adoption studies to require a more integrated and subjective view of the reality, recent researches (e.g.: Koo et al. 2015) are still using conventional methods represented by theories that try to explain the adoption phenomenon within a reductionism and fragmented view. This functionalist mainstream contradicts the nature and proposal of the GIS research because it seems not perceive the existence of different aspects (e.g., society, organisation and individual) involved into the environmental issues (Melville, 2010). In addition, the GIS proposal brings the idea of conscience and responsibility of individual and society with the natural environment and the need to understand how technology fits into a multiple level relationship.

Therefore, it is necessary to establish whether these models and previous theories that explain the IT adoption initiatives can be applied to the GIS studies (Molla, 2009). The technology adoption theories are going through a crisis characterized by the proliferation of new versions, and in this case, the emergence of GIS adoption studies represents a conflict within this context.

When crisis or conflicts appear, it means a sign that it is time to renew the instruments (Kunh, 1970). From this perspective, the GIS adoption field may open up new opportunities for future advances in the area. The emergence of GIS adoption requires that the functionalist paradigm of technology adoption studies be replaced by an interpretative paradigm, adopting an anti-positivism epistemological assumption.

RQ 3: How does human's behavior respond to the natural environment issues?

The deterministic assumption is reflected to the IS studies to explain the GIS adoption using factors such as strategies, market opportunities, profitability, and costs (e.g., Molla, 2009). In the literature, the facilitator factors of GIS adoption are determined by economic relations of the society, but little attention is given to the environmental concerns because human activities are seen only as economic activities, disregarding the self-determination and individual autonomy.

Further, adoption theories link a vision of the individual answering to behaviors that are determined by the external environment, for example, TAM determines the characteristics of a technology are able to determine the individual's behavior to adopt or reject technologies (Davis, 1986). In the reasoning, IDT suggests a set of innovation attributes that determine the adoption behavior of individuals (Rogers, 2005). In the GIS adoption studies, BAO framework proposes that individual's behavior is determined by external factors such as coercive and mimetic pressures (Gholami et al. 2013). However, to consider the natural environment aspects and its relation with IT and the organisation, it is necessary that researchers have a less mechanistic view about the adoption phenomenon and observe how this relationship happens in a more voluntary setting in which the individual is seen as an environment controller. In other words, assigning a more creative role for the individual involved in the phenomenon.

RQ4. How have data analysis techniques been conducted by GIS adoption studies?

The ontological, epistemological and human nature assumptions reflect directly on the methodological nature of the GIS studies. The methodology employed on this area treats the social world as natural, solid, real and external world to the individual, bringing a more objective approach in which the world is seen as a concrete reality. Studies (e.g., Gholami et al., 2013; Koo et al., 2015) adopt an objective nomothetic approach, using quantitative techniques for data analysis, suggesting and testing hypotheses in search of scientific rigor, and using methods of the natural sciences and standardized instruments (e.g.: pre-specified surveys).

Considering the theories that explain the phenomenon of technology adoption, the relationship among the GIS elements suggests that these theories fail to embrace the complexity of the phenomenon, reducing and excluding subjective aspects (e.g. environmental sustainability). Functionalist stream used on the theories does not connect to certain aspects of the GIS phenomenon. For example, the GIS study requires attention to different level of analysis linking

three entities: individuals, organisations and society. It provides a wider view of the phenomenon because the GIS implementation has impact in macro and micro-level variables (Melville, 2010). Despite this, the data collected at levels of analysis seems not to be appropriate for the theoretical propositions of the GIS studies. This implies that the link between the entities are usually disregarded or neglected in these studies.

Within this discussion, Melville (2010) reminds the need of use new methods, techniques, models and theories that can understand the relation between technology, organisation and natural environment. Therefore, the proposal is to suggest the use of a methodological ideographic approach within an interpretive paradigm. In other words, studies could explore in detail the backgrounds, life history and the daily routine of the individuals in relation to technology, organisational experience and the natural environment.

CONCLUSIONS

This paper proposed a paradigmatic reflection for the GIS adoption phenomenon based on the four meta-theoretical assumptions by Burrel and Morgan (1979). Discussion of this paper indicates that studies of technology adoption in GIS area remain within the functionalist dominant paradigm, using objective approaches that demonstrate the dominant presence by a set of assumptions given by: realism, positivism, determinism and nomothetic. Nevertheless, some studies (e.g., Jenkin et al., 2011) approach a more interpretative paradigm for analyzing constructs without strict controls of research and use methodologies within a more subjective emphasis.

Additionally, our findings indicates that the GIS adoption process seems to be more complex than the technology adoption theories can capture. It involves subjective aspects such as the relation between technology, organisation and natural environment as well as requires the analysis of different levels such as organization, society, and individual. To face this challenge, scholars would understand the GIS adoption process in the practice. It can open the "black boxes" of the process and generate knowledge in order to create novel theories and tools to investigate the phenomenon.

This study offers some contributions. The academic contribution is related to discussion about the dominant paradigm that involves IT adoption studies for bringing a proposal that threatens the "blind" progress (e.g., use of reason) and the uncontrolled knowledge of the area. The understanding of the subjective aspects that explain part of the GIS adoption process stands out as a managerial implication. For example, to investigate how organisations can stimulate more environmental awareness not only with an internal view, but also an external view. Manager must understand that his actions have circular and retroactively effects that will be essential to stimulate the organisational activities. Thus, individuals who are part of the organisational context (internal and external) can enhance the understanding that culture and awareness around the environmental sustainability are factors that can influence the GIS outcomes in a recursive relation. Additionally, the deep analysis of the GIS phenomenon can be

an opportunity renews the tools in order to develop new theories more appropriated for capturing specificities of the GIS adoption.

This study is not free of limitations. First, our paper does not review papers published after filtering the search. Second, the papers were selected from the WoS database. Due to this, it is possible that some paper could be excluded of the analysis. However, the WoS is a reliable database as well as include a large number of journals with highest scientific quality and contribution.

The rupture of the functionalist paradigm can originate from the discussion of the complex theory, emphasizing subjective experience of the individual in the creation of the social world. In this perspective, the main interest is to understand how individuals create, modify and interpret the world in which they are (Burrell and Morgan, 1979). Thus, for future studies, we propose the use of a methodological ideographic approach within the interpretative paradigm which the subject reveals its nature and characteristics during the process of investigation, that is, try to explore the backgrounds and history of life of the individuals in relation to the technologies, organisational experience and the natural environment.

Yet, we understand that the paradigms of the traditional studies of IT adoption are extended to the GIS studies. In face of our discussion, GIS adoption field reveals a tendency to adopt more interpretive theoretical position due to the nature of the phenomenon. In the interpretative paradigm, the knowledge is socially constructed and sustained by it, its relevance and meaning may be understood within their immediate social context (Burrell and Morgan, 1979). This science view is explicitly recognized in phenomenological and ethno-methodological studies (Burrell and Morgan, 1979). Future studies could be based on theoretical postures in which analyze the phenomenon from the individual's point of view or from social realities. For example, scholars could focus on the individuals' point of view and the meanings of their experiences, objects, and activities, considering the interactions and discussions among these individuals about structural aspects (e.g., culture, beliefs, and knowledge).

Future studies could perform a semi-standardized interview in order to rebuild subjective theories (Flick, 2009). In the subjective theories, the interviews have a complex set of knowledge about the subject under investigation (Flick, 2009). Specifically, the semi-standardized interview could wide concepts about environmental sustainability and sustainable development from individual's point of view. Yet, it could help understanding of individual's knowledge about the global environmental consequences as well as they search technological solutions addressing the environmental concerns. Thus, the construction of the theory could perform studies to understand "organisational actions to adopt green technologies" in order to outline the evolutionary stage of GIS adoption.

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REFERENCES

Benbasat, I.; and Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems*, (8:4), 211-218.

Bengtsson, F.; and Àgerfalk, P. J. (2011) Information technology as a change actant in sustainability innovation: insights from Uppsala. *Journal of Strategic Information Systems*, 20, 96-112.

Bohas, A.; and Poussing, N. (2016). An empirical exploration of the role of strategic and responsive corporate social responsibility in the adoption of different green IT strategies. Journal of Cleaner Production, 122, 240-251.

Bone, C.; Alessa, L.; Altaweel, M.; Kliskey, A.; and Lammers, R. (2011) Assessing the impacts of local knowledge and technology on climate change vulnerability in remote communities. *International Journal of Environmental Research and Public Health*. 8, 733-761.

Bose, R.; and Luo, X. (2011). Integrative framework for assessing firms' potential to undertake Green IT initiatives via virtualization – A theoretical perspective. *Journal of Strategic Information Systems*, 20, 38-54.

Burrel, G.; and Morgan, G. (1979). Sociological paradigms and organizational analysis: elements of the sociology of corporate life, Heineman Educational Books: London.

Burton-Jones, A.; Gallivan, M. J. (2007). Toward a deeper understanding of system usage in organizations: a multilevel perspective. MIS Quartely, (31: 4), 657-679.

Buttler, T. (2011). Compliance with institutional imperatives on environmental sustainability: building theory on the role of Green IS. Journal of Strategic Information Systems, 20, 6-26.

Cai, S.; Chen, X.; and Bose, I. (2013). Exploring the role of IT for environmental sustainability in China: An empirical analysis. *Int. J. Production Economics*, 146, 491-500.

Chen, J. V.; Yen, D. C.; and Chen, K. (2009). The acceptance and diffusion of the innovative smart phone use: a case study of a delivery service company in logistics. *Information & Management*, 46, 241-248.

Chou, D. C.; and Chou, A. Y. (2012). Awareness of green IT and its value model. Computer Standards & Interfaces, 34, 447-451.

Compeau, D. R.; Meister, D. B.; and Higgins, C. A. (2007). From prediction to explanation: reconceptualizing and extending the perceived characteristics of innovating. *Journal of the Association for Information Systems*, (8:8), 409-439.

Corbett, J. (2013) Designing and using carbon management systems to promote ecologically responsible behaviors. Journal of the Association for Information Systems, (14:7), 339-378.

Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: theory and results. Doctoral dissertation. Sloan School of Management. Massachusetts Institute of Technology.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319-340.

Dao, V.; Langella, I., and Carbo, J. (2011) From green to sustainability: information technology and an integrated sustainability framework. *Journal of Strategic Information Systems*, 20, 63-79.

Dedrick, J. (2010). Green IS: concepts and issues for information systems research. *Communications of the Association for Information Systems*, (27:11), 173-184.

Deng, Q.; and Ji, S. (2015). Organizational green IT adoption: concept and evidence. *Sustainability*, 7, 16737-16755.

Devolver, P; Pynoo, B.; Duyck, P.; and Sijnave, B. (2008). Personality, technology belief contexts and acceptance: framework and empirical testing. *Proceedings Twenty Ninth International Conference on Information Systems*, Paris.

Elliot, S. (2011). Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation. *MIS Quartely*, (35:1), 197-236.

Flick, U. An introduction to qualitative research. 4 ed. London: Sage, 2009.

Gallivan, M. J. (2001). Organizational adoption and assimilation of complex technological innovations: Development and application of a new framework. *Advances in Information Systems*, (32:3), 51-85.

Gefen, D.; and Straub, D. (2000). The relative importance of perceived ease of use in IS adoption: a study of e-commerce adoption. *Journal of the Association for Information Systems*, (1:8), 1-23.

Gholami, R., Watson, R. T., Hasan, H., Molla, A., and Bjørn-Andersen, N. (2016). Information systems solutions for environmental sustainability: how can we do more? *Journal of the Association for Information Systems*, (17:8), 521-536.

Gholami, R.; Sulaiman, A. B.; Ramayah, T.; and Molla, A. (2013). Senior managers' perception on green information systems (IS) adoption and environmental performance: Results from a field survey*. Information & Management*, 50, 431-438.

Goodhue, D. L. (2007). Comment on Benbasat and Barki's "Quo Vadis TAM" article. *Journal of the Association for Information Systems*, (8:4), 219-222.

Gregor, S. (2006). The nature of theory in information systems. *MIS Quarterly*, (30:3), 611-642.

Hanne, F. Z. (2011). Green-IT: why developing countries should care? *International Journal of Computer Science Issues*, (8:4), 424-427.

He, Q.; Duan, Y.; Fu, Z.; and Li, D. (2006) An innovation adoption study of online e-payment in Chinese companies. *Journal of Electronic Commerce in Organizations*, (4:1), 48-69.

Jenkin, T. A.; Mcshane, L.; and Webster, J. (2011). Green information technologies and systems: employees' perceptions of organizational practices. *Business & Society*, (50:2), 266-314.

Koo, C.; and Chung, N. (2014). Examining the eco-technological knowledge of Smart Green IT adoption behavior: a self-determination perspective. *Technological Forecasting & Social Change*, 88, 140-155.

Koo, C.; Chung, N.; and Nam, K. (2015). Assessing the impact of intrinsic and extrinsic motivators on smart green IT device use: reference group perspectives. *International Journal of Information Management*, 35, 64-79.

Kunh, Thomas S. (1970). The structure of scientific revolutions. Second Edition. USA: University of Chicago Press.

Lee, Y.; Kozar, K. A.; and Larsen, K. R. T. (2003). The technology acceptance model: past, present, and future. *Communications of the Association for Information Systems,* 12, 752-780.

Melville, N. P. (2010). Information systems innovation for environmental sustainability. *MIS Quarterly*, (34:1), 1-21.

Molla, A. (2013). Identifying IT sustainability performance drivers: instrument development and validation. Information Systems Frontiers, 15, 705-723.

Molla, A. (2009). Organizational motivations for Green IT: exploring Green IT matrix and motivation models. *Association for Information Systems*, 13.

Molla, A.; Pittayachavan, S.; Corbitt, B.; and Deng, H. (2009). An international comparison of green IT diffusion. *International Journal of e-Business Management*, (3:2), 33-23.

Moore, G. C.; and Benbasat, I. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research*, (2:3), 192-222.

Nolim, J. (2010). Sustainable information and information science. Information Research, 15(2). Disponível em [http://www.informationr.net/ir/15-2/paper431.html. Acesso em 24/03/2015](http://www.informationr.net/ir/15-2/paper431.html).

Oinas-Kukkonen, H.; and Harjumaa, M. (2009) Persuasive systems design: key issues, process model, and systems features. *Communication of the Association for Information Systems*, (24:1), 485-500.

Park, J. H.; and Jeong, H. Y. (2014). Cloud computing-based jam management for a manufacturing system in a Green IT environment. *J. Supercomput*, 69, 1054-1067.

Pavlou, P. A.; Fygenson, M. (2006). Understanding and predictiong electronic commerce adoption: an extensive of the theory of planned behavior. MIS Quarterly, (30:1), 115-143.

Ryoo, S. Y.; and Koo, C. (2013). Green practices-IS alignment and environmental performance: The mediating effects of coordination. *Information Systems Frontiers*, 15, 799-814.

Saldaña, J. The coding manual for qualitative researchers. SAGE, 2009.

Titah, R.; and Barki, H. (2009). Nonlinearities between attitude and subjective norms in information technology acceptance: a negative synergy? *MIS Quarterly*, (33:4), 827-844.

UN. (1987). Report of the World Commission on Environment and Development. General Assembly Resolution 42/187 em <http://www.un.org/documents/ga/res/42/ares42-187.htm> acessado em 24/02/2015.

Unhelkar, B. (2011) Green IT strategies and applications: using environmental intelligence. New York: CRC Press.

Venkatesh, V; and Davis, F. D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, (46:2), 186-204.

Venkatesh, V; Davis, F. D.; and Morris, M. G. (2007). Dead or alive? The development, trajectory and future of techonology adoption research. *Journal of the Association for Information Systems*, (8:4), 267-286.

Venkatesh, V; Morris, M. G.; Davis, G. B.; and Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly*, (27:3), 425-478.

Wang, X.; Brooks, S.; and Sarker, S. (2015). A review of green IS research and directions for future studies. *Communications of the Association for Information Systems*, (37:21), 395-429.

Watson, R. T.; Boudreau, M-C.; and Chen, A. J. (2010). Information systems and environmentally sustainable development: energy informatics and new directions for the IS community. *MIS Quarterly*, (34:1), 23-38.