

8-2015

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Recommended Citation

Wang, Xuequn; Brooks, Stoney; and Sarker, Saonee (2015) "A Review of Green IS Research and Directions for Future Studies," *Communications of the Association for Information Systems*: Vol. 37, Article 21.

Available at: <http://aisel.aisnet.org/cais/vol37/iss1/21>

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A Review of Green IS Research and Directions for Future Studies

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Abstract:

As practitioners become more interested in green information systems, the IS academic community requires direction in how to examine this important phenomenon. We conduct a systematic and comprehensive review of the academic literature surrounding green IS and compares the results with those from the practical literature. Through this review, we identify the main categories in the literature and assess the current state of research into green IS. We discuss some limitations of the current literature, posit research directions for future scholars, and address the gaps in the current research on green IS.

Keywords: Green IS, Green IT, Sustainability Literature Review, Research Directions.

The manuscript was received 01/16/2013 and was with the authors 15 months for 3 revisions.

1 Introduction

As organizations have become concerned about sustainability, many have begun to adopt sustainability strategies and technologies such as environmental management systems (EMS) to improve environmental and economic performance (Melville, 2010). Given the size of organizations' IT investments, green information systems (IS) is gaining in relevance to support sustainability. Green IS refers to "the initiatives to utilize IT infrastructure to change organizational processes and/or practices to improve energy efficiency and reduce the environmental impacts, and to introduce environmentally healthier products and/or services" (Brooks, Wang, & Sarker, 2012, p. 19). Practitioners have been paying attention and proposed that green IS may be a technological solution that supports sustainability (green IT)¹. Scholars have argued that green IS was the most important strategic technology for 2008 (Thibodeau, 2007), while McKinsey (2008) has argued it to be a way to reduce 3 percent of the greenhouse gas (GHG) emissions worldwide by 2020. Green IS initiatives may even reduce GHG emissions by promoting non-wasteful practices such as telecommuting and productive uses of energy.

An example of green IS initiatives is IBM. On May 11, 2007, the company launched a \$1 billion service initiative to build and redesign data centers with the purpose of consuming less energy. Later, as an extension of Project Big Green, IBM launched a program to allow mainframe customers to monitor their energy consumption in real time (CACM Staff, 2007). Business researchers have examined sustainability from marketing (Belk, Painter, & Semenik, 1981), operational (Corbett & Kirsch, 2001), and management perspectives (Gladwin, 1993; Shrivastava, 1994). Recent IS literature has observed the importance of sustainability and tried to better understand green IS (Melville, 2010; Watson et al., 2010), but there seems to be a lack of direction in terms of specific topics and approaches to it (Brooks et al., 2012).

In this paper, we offer specific research directions for green IS for researchers. In order to address gaps in the literature, we assess the state of green IS studies by reviewing current research on green IS and related concepts. Given the ongoing debate in IS academia about rigor and relevance (Benbasat & Zmud, 1999; Davenport & Markus, 1999; Lee, 1999; Lyytinen, 1999), IS academics have attempted to follow practical topics and conduct research on issues being discussed in the practical literature. We believe that any review of the research on green IS would be incomplete without reviewing both academic and practical approaches. Note that practitioners recognized the concept of green IS much earlier than academics, and, thus, an analysis of the practical literature can help to identify gaps in the academic literature, if any, and thereby guide future researchers toward those areas.

More specifically, we address two research questions:

RQ1: *Which areas of green IS are currently being addressed by IS academics and practitioners?*

RQ2: *What relevant research directions have arisen for future studies on green IS?*

The article is organized as follows: in Section 2, we review both the academic and practical literature on green IS. In Section 3, we assess the current state of the research. Based on the results of those reviews, in Section 4, we pose possible directions for future study in the form of relevant research questions that may address any known gaps.

2 Literature Review

2.1 Method

To obtain a sense of the current state of green IT/IS studies, we examined both the academic and practical literature by following Dube and Pare (2003)'s inductive categorization method: we carefully selected appropriate conferences and journals, we identified the papers relevant to the review, we created categories based on their content, we analyzed percentages and trends, and, finally, we proposed directions for future studies.

¹Boudreau, Chen, and Huber (2007) summarize the key difference between IT and IS as "an information technology (IT) that transmits, processes, or stores information" whereas "an information system (IS) is an integrated and cooperating set of software using information technologies to support individual, group, organizational, or societal goals" (p. 2). This differentiation applies to Green IT and IS as well.

2.1.1 Conference and Journal Selection

We began our academic literature review by searching the eight premiere academic IS journals: *MIS Quarterly (MISQ)*, *Information Systems Research (ISR)*, *Journal of Management Information Systems (JMIS)*, *Journal of the Association for Information Systems (JAIS)*, *European Journal of Information Systems (EJIS)*, *Information Systems Journal (ISJ)*, *Journal of Strategic Information Systems (JSIS)*, and *Journal of Information Technology (JIT)*². Because of the novelty of green IS, we expanded our search to include other journals and conference proceedings, specifically those of the Americas Conference on Information Systems (AMCIS), European Conference on Information Systems (ECIS), Pacific Asia Conference on Information Systems (PACIS), and International Conference on Information Systems (ICIS). For the practical literature, we reviewed multiple practitioner publications including *MIS Quarterly Executive (MISQE)*, *Communications of the ACM (CACM)*, *IT Professional*, *Chief Information Officer (CIO) Magazine*, and *PC World Magazine*. For the purposes of this review, we eliminated advertisements and editorials. Given that “green IT” or “green IS” are still new terms that yield relatively few publications, we used Google Scholar to locate useful academic publications and searched via Google for practitioner publications.

2.1.2 Identification of Relevant Papers

The term “green IT” was first used in *CIO Magazine* in 2007, which, therefore, serves as the beginning date for our study, which covers the years 2007-2012³. We used the terms “green”, “sustainable”, “sustainability”, “smart grid”, “grid computing”, “environment”, “climate”, “disposal”, “recycling”, “e-waste”, “energy informatics”, “energy efficiency”, “emission reductions”, “CO2 reduction”, “carbon productivity”, “greenhouse gas”, and “corporate responsibility” to identify relevant papers by searching abstracts and key words. We conducted this search by going through the outlets above.

2.2 Categorization

Since no methodology currently exists for classifying green IS research, we followed Dube and Pare’s (2003) guidelines, which focus on the rigor of positivist case studies in IS research. Two of the authors separately coded each paper identified to capture their primary intent. This coding process resulted in a nearly 94 percent consistency, and the two coding authors met to resolve the coding differences.

Based on coding the published academic literature, we identified four categories of papers: initiation, enterprise strategies and practices, adoption framework, and outcomes. Specifically, to come up with the classification, we did not focus on the papers’ technical aspects. Instead, we paid more attention to the issues that each paper discussed or tried to address. For example, one paper may discuss data warehouses while another deals with a smart grid. As long as they both focus on the outcomes of green IS initiatives, we put them into the same category, “outcomes”. Our rationale is that, since IT and IS advance at a dramatic speed, this approach can help us develop a more stable and useful classification schema. Thus, papers dealing with the same technology may be classified into different categories. For example, we found six papers examining smart grid or grid technology. While one papers may deal with practices of smart grid, another paper may focus on outcomes of smart grid. In such a context, those two paper essentially focus on different themes, and we put them into different categories. After we identified papers, we coded each one and classified them into specific categories.

Two points should be noted. First, because our review shows that effects tend to be mixed rather than positive, we use outcomes rather than benefits to refer to papers that focus on the effects of green IS initiatives. Second, we chose to classify *initiation* and *adoption framework* as separate categories since the papers in each category have a different focus, papers involving initiation focus on how different factors influence the adoption of green IS, and papers dealing with the process and steps follow organizations that implement green IS initiatives. As used here, papers in the initiation category did not cover any aspect of green IS initiatives after their adoption, and papers in the adoption framework category might or might not cover initiation even if that is deemed the first step in implementation⁴. Thus,

² At the time of the review, these eight journals are proposed to be top journals by senior scholars: <http://start.aisnet.org/?SeniorScholarBasket>

³ We also include conference proceedings in 2013 to reflect recent academic literature.

⁴ This discussion applies to the context where one paper belongs to one of two categories. One paper may of course belong to both categories, in which case the paper examines both factors influencing the initiation of green IS and the steps of implementing green IS initiatives.

in Ijab, Molla, KAssahun, and Teoh's (2010) lifecycle framework, the first step was to design and develop a framework that does not cover the factors influencing the initiation of green IS. Therefore, we did not combine these categories.

2.2.1 Academic Literature

We placed 44 papers discussing factors related to adopting, launching, and initiating green IS in the initiation category, while we categorized 66 papers discussing different approaches and strategies of treating and managing green IS initiatives as enterprise strategies and practices. We categorized 11 papers under adoption framework when they focused on processes of adoption and implementation. Finally, we categorized 37 papers that focused on the effect of green IS initiatives (e.g., energy efficiency, cost savings, profit) as outcomes. Again, because a paper could belong to different categories, we included the category "other" to include those studies that review agendas for green IS research (Appendix A summarizes each paper).

2.2.2 Practical Literature

The practical literature contained four paper categories: we categorized 14 as initiation, 47 as enterprise strategies and practices, six as adoption framework, and 25 as concerned outcomes. Again, one paper may comprise more than one category (Appendix B summarizes each paper).

2.3 Analysis of Percentages and Trends

Based on our review, the academic literature revealed other patterns of interest in green IS compared with the practical literature (see Appendix C for details). The green IS academic literature appeared starting in 2008, given that there is only one review paper in 2007. Academic research had a stronger focus on initiation and enterprise strategies and practices concerning green IS as opposed to outcomes. One reason for this may be that, in the academic literature, the effects of green IS initiatives are not always positive. Since the results of outcomes are mixed, we anticipate that the literature will pay greater attention to the outcomes of green IS initiatives in an attempt to uncover the reasons why some outcomes are positive and others are negative or neutral. The number of papers on adoption frameworks was stable and relatively small.

In the practical literature, there was a high and relatively consistent focus on the outcomes of green IS initiatives, indicating that practitioners are interested in how such initiatives may result in various benefits. To expand their understanding of the outcomes of green IS, practitioners were also interested in enterprise strategies and practices of green IS, evidenced by the large number of papers starting in 2009. From 2007-2008, many papers focused on initiation, but little did after that period. One reason for this decline may be a changing business environment that expects companies to initiate and adopt green IS. That is, it is no longer a question of if, but rather how and when.

2.4 Academic Literature Review

2.4.1 Initiation

According to the literature, a variety of factors may influence initiation of green IS at the individual and organizational level, and previous studies have used methods such as case studies, experiments, secondary data, and surveys. At the individual level, the literature has found that, in particular, social influence and environmental concerns may influence the adoption of green IS (Kranz & Picot, 2011, 2012).

At the organization level, we observed environmental, organizational, and technological factors. The literature has identified such factors as environmental uncertainty (Lei & Ngai, 2012; Schmidt et al., 2010), competition and institutional forces (normative, coercive, and mimetic pressure), and stakeholder pressure (market, industrial, and regulatory) (Simmonds & Bhattacharjee, 2012). All of these are important in green IS initiatives. Of these, institutional forces received the most attention: five studies examined institutional forces via survey, case studies, and conceptual models.

The literature identified the following organizational aspects: top management support (Nedbal, Wetzlinger, Auinger, & Wagner 2011), leadership (Mann, Grant, & Singh Mann, 2009), commitment of resources (Bose and Luo, 2011), operational inefficiencies (Simmonds & Bhattacharjee, 2012), internal resistance (Mann et al., 2009), bottom-line considerations (Kuo & Dick, 2010), Green IT/IS policy (Alaraifi

et al., 2011), IT/IS department, and industry type and business size (Mann et al., 2009). These factors deal with organizational strategies such as leadership and characteristics such as business size and reactions to green IS initiatives, including internal resistance.

The past literature has also examined the role of technological factors. In their green IT readiness model, Molla, Cooper, and Pittayachawan (2009) cite technology as an important factor for influencing organization adoption. Nedbal et al. (2011) found that technological compatibility and complexity may influence green IS initiatives. At the same time, technological factors have not received as much attention as environmental and organizational factors, and few studies examined technological factors in specific kinds of green IS initiatives, with the exception of Alaraifi et al. (2011), who focused on sensor information systems and data centers.

Thus, since several studies identify important organizational and environmental factors that may influence green IS initiatives, such factors must be considered when initiating a green IS project. Some work has examined technological factors, but this is an area that requires further investigation.

2.4.2 Enterprise Strategies and Practices

Since IS researchers are interested in the potential of green IS initiatives from a strategic perspective, the literature includes different strategies and practices of green IS at different levels (technological, individual, organizational, and industrial) using a variety of methods (design science, case study, simulation, data mining, experimental, secondary data, survey). At the technology level, past studies have used design science or simulation to develop better green IS practices. For example, Thoroe, Appelhanz, and Schumann (2011) show how distributed RFID-based waste management information systems can support the recycling of electronics. At the individual level, Loock, Landwehr, Staake, Fleisch, and Pentland (2012) have suggested that using reference groups close to the energy consumers may save energy.

At the organizational level, studies have focused on different green IS strategies. Sayeed and Gill (2009) show that, by mobilizing dynamic resources while implementing green IT initiatives, organizations were able to take advantage of green IT for strategic purposes. Corbett (2012) argues that organizations may take a wait-and-see approach to institutional pressures; if they perceive benefits, organizations may become more engaged in green IS initiatives. Ereik et al. (2011) proposes a strategic green IT alignment framework and identifies four green IT strategic approaches: efficiency, transformation, innovation, and responsibility, while Loeser, Ereik, and Zarnekow (2012) identify green IS as yielding efficiency, innovation, transformation, and credibility.

The strategies and practices of green IS initiatives have been evaluated at several different levels. This stream of investigation may have great potential for identifying practical information. Depending on the size and scope of the project, multiple strategies should be considered and used because the changes brought about by green IS rarely reside at a single level. Many of works identified the existence of strategies, but few have served as a guide for practitioners on which course to take.

2.4.3 Adoption Framework

Relatively few studies examined the frameworks for adopting green IS initiatives. Instead of viewing initiation as the end, these studies viewed post-initiation stages to examine implementation of green IS initiatives in more detail. Some studies saw initiation as the starting point. Mann et al. (2009) develop a three-step implementation framework for green IT initiatives: 1) determining external and internal factors, 2) determining the sophistication of strategy, technology, and processes, and 3) measuring sustainability of a proposed venture. Lei and Ngai (2012) suggest that the assimilation of green IS also includes three steps—initiation, adoption, and routinization. Other studies have examined more deeply how organizations engage in green IS initiatives. Van Osch and Avital (2010) illustrate how a company could go from green IT to green IS to sustainable innovation. Hjalmarsson and Lind (2011) show how organizations pass through different stages: entrepreneurial, collective, formalization and control, and an elaboration stage to incorporate Green IS initiatives in organizations.

However, the research provided few frameworks for adopting green IS initiatives. Note that, like most IS projects, initiating implementation is just the beginning of an entire process.

2.4.4 Outcomes

Consistent with the concept of sustainability (Kleindorfer, Singhal, & Wassenhove, 2005; Porter & Kramer, 2006), the literature has included three major categories of outcomes: environmental, economic, and social outcomes. Based on our review, the literature has incorporated a variety of methods such as case study, survey, experiment, simulation, and secondary data to deal with both the individual and organizational level.

Twenty-three empirical studies in the outcomes category examined environmental outcomes; the majority of these studies found that green IS initiatives had a positive impact on the environment. Gimenez, Sierra, Rodriguez, and Rodon (2012) found that environmental practices implementation was positively related to firms' environmental performance. On the other hand, Haigh and Griffiths (2008) found that green IS initiatives could result in positive or negative environmental outcomes for service-oriented operations. Yim (2011) found that green IS initiatives such as providing information on energy consumption could have either a positive or no effect at the individual level (i.e., energy consumption).

Twenty-one studies examined the economic outcome of green IS. Hopper and Rice (2008) show how system-level optimizations of power consumption can be achieved, which, in turn, lowered operating costs. In another study, Vykoukal, Wolf, and Bench (2009) argue that green IT initiatives (grid technology) have economic benefits for companies. As with environmental outcomes, researchers have shown that green IS initiatives may not always generate a positive economic effect. DesAutels and Berthon (2011) found that, when personal computer manufactures complied with sustainability regulations, the cost to consumers would probably rise. Takeda, Rowe, Habib, de Corbiere, and Antheaume (2012) show that using consolidation centers might not reduce costs or generate a positive economic outcome.

Social outcomes received little attention in the literature, with only two studies dealing with social outcomes. One example was Tarafdar, Modi, Roy, and Datta (2010), who show that IT services providers could facilitate the adoption of sustainable IT in client organizations, leading to positive social benefits such as greater employee wellbeing and the recycling of obsolete hardware and software.

Overall, the literature investigated the outcome of green IS initiatives using three outlooks. The majority of environmental outcomes were positive, economic outcomes were positive or neutral, and social outcomes required further investigation.

We also examined the philosophical perspectives (e.g., positivist, interpretive, or critical) and theories behind studies. As Appendix A shows, we found that 80 studies followed a positivist perspective and that 51 studies followed an interpretive perspective. We found that only two studies that used a critical perspective and that previous studies have used various theories such as institutional and resource-based views.

2.5 Practical Literature Review

As with the academic literature, we reviewed the practical literature and identified four paper classes: initiation, enterprise strategies and practices, adoption framework, and outcomes. We briefly discuss the papers in each category. (Interested readers may refer to Brooks et al. (2012) for more details.)

2.5.1 Initiation

Paper in this category discussed different factors influencing the implementation of green IS initiatives. Dell mentioned how cost savings were often the primary driver, and shareholder or regulatory pressures might also influence the initiation of green IT (Beach, 2008).

Enterprise Strategies and Practices

Some papers provided suggestions on how to achieve benefits from green IS initiatives. Murugesan (2008) present a holistic approach to green IT and describe the phenomenon in four complementary paths: green use, green disposal, green design, and green manufacturing.

2.5.2 Adoption Framework

Some papers identified the different steps of adopting green IS. Mines, Brown, and Lee (2007) discuss green IT services engagements as requiring three steps: assessment, when organizations understand their current situation and create a baseline of potential green IT initiatives; planning, when organizations

develop roadmaps for specific green IT initiatives; and implementation, when organizations activate a specific green IT initiative.

2.5.3 Outcomes

Given that green IS (or IT) is a new phenomenon, some papers try to inform managers that these initiatives are not merely a liability but also that companies might benefit from adopting green IS. Overby (2007) reports that VistaPrint realized significant savings and cut carbon emissions using green IT initiatives. Overall, while practitioners have begun to pay attention to green IS, they have mainly focused on energy efficiency, such as designing energy-efficient hardware and reducing the energy consumption of data centers (Boudreau et al., 2007). Our search revealed no papers on green IS. Given that this is a complex and multi-dimensional phenomenon, we suggest that practitioners may wish to pay more attention to other aspects of green IS so they may enjoy the benefits of green IS. The narrow focus on green IS initiatives could limit the potential of green IS and prevent companies from thinking about these initiatives from a strategic perspective.

Still, the practical literature may complement existing academic studies in different ways. First, the academic literature has paid little attention to technological characteristics of green IS, and few studies have differentiated between the various types of green IS initiative. The description of different green IS initiatives from a practical standpoint could help scholars identify technological characteristics of green IS. Kurp (2008) discussed different ways of reducing data center power consumption, including better cooling technologies. Such characteristics could be valuable for understanding certain green IS initiatives.

Because few studies have tried to derive strategies for managing green IS initiatives, the practical literature offers a good starting point. Murugesan (2008) suggests three approaches that organizations could take, including a tactical incremental approach, a strategic approach, and a deep green approach, and he provides examples of each approach. Future studies could build on Murugesan's paper to examine how strategies can apply to different green IS initiatives.

After reviewing both types of literature, we did not find a large gap between them. Both communities devoted attention to the outcomes of green IS. In particular, practitioners wanted to know what this new kind of IT could bring to their businesses and how organizations could potentially benefit from different kinds of initiatives. The most common categorical area for both scholars and practitioners was the initiation and strategies of green IS. Given that such initiatives are relatively new, managers may need to justify why an organization should use them and how they should proceed to allow the maximum chance for success.

Both communities are beginning to realize the potential of green IS initiatives beyond recycling and energy efficiency. The scholarly literature seems to be a step ahead of the practical literature in examining further aspects of green IS initiative beyond the technical. In the category of enterprise strategies and practices, papers on eco-efficiency (DeSimone & Popoff, 1997) moved into eco-effectiveness (McDonough & Braungart, 1998) and eco-collaboration (Brooks et al., 2012), showing once again that green IS initiatives may be more valuable and beneficial than green IT initiatives and deserve the attention of IS scholars.

Although benefits are a main reason why organizations adopt green IS initiatives, they are not the only reason. Other factors such as government regulation and attitudes toward green IS initiatives may play important roles. While the lack of published work on the adoption framework of green IS may be understandable given that these initiatives are still fairly new and there may be little information and few cases available, whether organizations can harvest the benefits of green IS initiatives largely depends on the degree to which initiatives are successfully implemented. Based on the previous IS literature, we know that investing in IT may not necessarily lead to the realization of benefits and that organizations often fail to implement IT successfully (Barker & Frolick, 2003). Therefore, this topic may be at least as important as other topics, and more studies are needed in this area.

3 Assessment of the Current State of Green IS Research

Based on our review, the green IS phenomenon was first examined in 2007. Since then, academic researchers have examined different outcomes to understand the factors influencing green IS initiatives. More recently, researchers have begun to realize the potential of green IS initiatives from a strategic perspective by looking beyond direct benefits such as energy efficiency. However, ways of successfully implementing green IS initiatives has received relatively little attention.

Finishing this review, we ask whether we as IS researchers have done a good job of studying green IS. The answer is arguable. First, the number of papers we identified was limited: we identified only 12 papers in the eight leading IS journals, eight from a special issue in *JSIS* and the other three papers citing “issues and opinions” or “theory and review” from *MISQ*.

3.1 Limitations of the Current IS Research

While past studies have identified environmental and organizational factors that may influence initiation of green IS at the organizational level, few have examined technological factors of green IS initiatives. It has been well established in the IS domain that a multitude of technological factors may influence adoption and use of IS. In order to predict usage, one needs to understand these factors from the context of green IS. However, few studies have looked at green IS adoption by individuals in the context of the organization. One exception is Chang, Yen, Li, Chang, and Chen (2011), who collected data from 93 accountants who worked in Taiwan manufacturing, to show that organizational culture, individual demands, and value may influence individual attitudes regarding environmental accounting systems.

While the literature has included different strategies related to green IS, many studies simply classify them and do not develop theories to examine what factors lead to different green IS strategies and their consequences. We do not know if some strategies align with success for the different types of initiatives.

Scant attention has been paid to the theoretically important category of frameworks for adopting green IS initiatives, which represents the major limitations of the current literature. Frameworks proposed so far seem less driven by theory. There is a need for a strong theoretical foundation to combine different green IS studies so that these may tell a complete, coherent story. At the same time, the attributes of green IS initiatives have been relatively ignored. Since there are different kinds of initiatives and that they may be huge, understanding how attributes of green IS initiatives can influence adoption and implementation seems relevant.

The literature has examined environmental, economic, and social outcomes of green IS initiatives, but the results have been mixed, indicating that further theoretical development is needed to explain results. In addition, few studies have examined the outcomes of green IS initiatives at the individual level since individuals in an organization can make or break certain types of initiative. For example, in very complex changes, employees’ ability to adapt can be critical to their success. Thus, understanding the impact both on and by individuals is important.

We also investigated the philosophical perspectives and theoretical foundations of each study (see Appendix A) and found that most studies follow positivist or interpretive perspectives in examining green IS, but that some take a critical perspective. As Orlikowski and Baroudi (1991) argues, a critical philosophy does not assume social relations in organizations are necessarily stable and orderly but rather that they are constantly undergoing change. In other words, such a social reality is historically constituted and not restricted to a particular state. In this way, a critical philosophy could be helpful in examining how the attributes of a particular organization may influence or restrict adoption of new green IS initiatives, any resulting changes, and how such changes influence future adoption of green IS initiatives. This perspective may be overlooked since such initiatives are still a new phenomenon and there are few research cases that represent longitudinal changes in organizations. We suggest IS researchers consider applying this perspective to certain future studies.

We also looked at the theoretical foundations of past literature (see Appendix A) with two key findings. First, many studies are exploratory and do not use any specific theory⁵. Second, while previous studies have used different theories, many take the resource-based view (incorporating the natural resource-based view) or institutional theory because, for one, scholarly green IS research is immature and IS researchers lack strong theory and focused research direction to guide their studies. Therefore, while these theories can help us understand green IS, future researchers may wish to adopt different theoretical lenses.

Table 1 presents the main findings of our review. Each category had notable limitations; most studies follow positivist or interpretive perspectives and many take the resource-based view or institutional theory.

⁵By putting N/A in the theory column, we do not mean to imply that such studies are not theory driven but rather that we cannot identify the overall theoretical foundation adopted. For example, studies may develop hypotheses based on the literature without articulating an overall theoretical foundation, or may use grounded theory to guide their research.

Since green IS has become increasingly important and received more attention from the practical literature, the IS research community needs to maintain continued focus on this topic.

Table 1. Main Findings

Category	Main Findings	Limitations/recommendations
Initiation	On the organization level, previous studies have identified important organizational and environmental factors.	On the organizational level, few studies have examined how technological factors influence initiation of Green IS initiatives. Few studies have examined individual adoption of green IS initiatives in the context of the organization.
Enterprise strategies and practices	Previous literature has examined different strategies and practices of green IS from technology, individual, organization and industry levels.	Few studies have examined different green IS strategies and how these lead to the success of different types of initiative.
Adoption framework	Previous literature has proposed some frameworks for green IS adoption and implementation.	Frameworks are less theory driven and do not differentiate among types of green IS initiative. More studies are needed.
Outcomes	On the organizational level, previous studies have examined the environmental and economic outcomes of green IS initiatives.	Results of environmental and economic outcomes are mixed; few studies have examined social outcomes or outcomes at the individual level.
Philosophical perspective	Most studies took a positivist or interpretive perspective.	Few studies have adopted a critical perspective for understanding green IS.
Theoretical foundation	Many studies used the resource-based view (including natural resource-based view) or institutional theory.	Many studies were less theory driven; future research may wish to adopt other theories to examine green IS.

4 Recommendations for Future Green IS Research

4.1 Development of a Green IS Framework

This review helped us not only identify different areas of research but also posit the relationships between these areas. Figure 1 captures these areas of research and their interrelationships in the framework with gray text, boxes, and arrows representing areas that require future research. Our framework integrates past studies to help propose research questions for future studies.

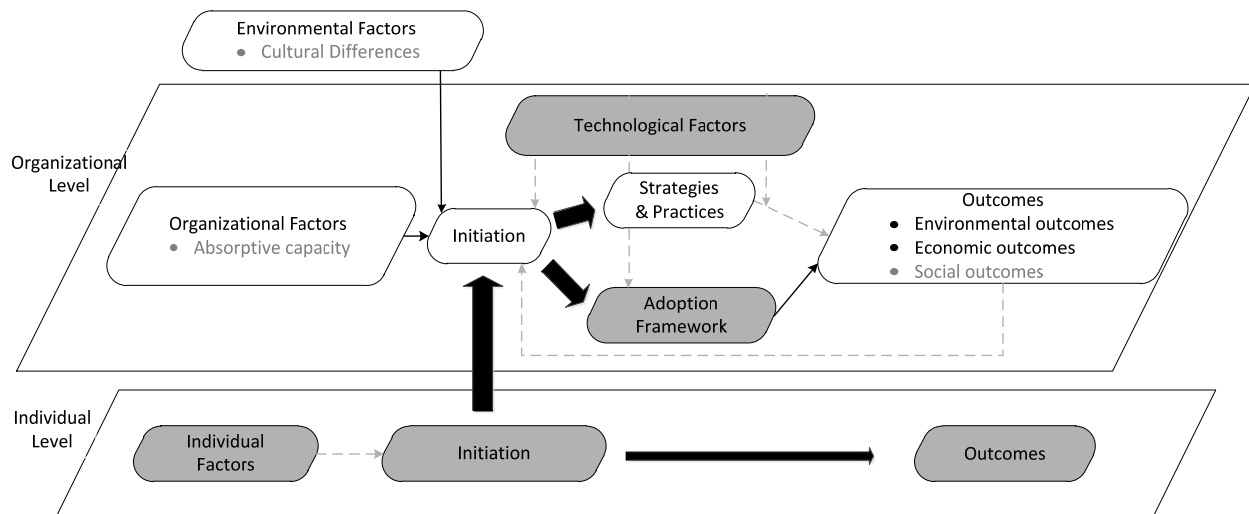


Figure 1. Facets of Green IS and Their Inter-Linkages (Areas Lacking Empirical/Theoretical Examination Shown in Gray)

This framework suggests that, in the IS discipline, green outcomes are the primary dependent variable, whether on the organizational or the individual level. After the initiation of green IS, organizations use different strategies and practices, areas of research that have received ample attention, while few studies have examined the adoption framework that organizations may use following initiation.

Although organizational outcomes have received much attention in the literature, our review shows that the results are mixed for environmental and economic outcomes and that few studies have examined the social outcomes of green IS. More studies are needed to develop different aspects of these outcomes in various contexts. Researchers may also wish to examine how outcomes influence the future initiation of green IS.

While previous studies have examined environmental and organizational factors influencing the initiation of green IS, more studies are needed. Besides these, technological factors have received little attention. We believe such factors play important roles in the initiation decision in terms of choosing adoption frameworks and interacting with strategies and practices to influence the outcomes of green IS and explain why they are mixed.

Our review shows that few studies have examined green IS at the individual level in organizations. Since individuals are the ones who essentially use green IS initiatives, more study is needed to learn how they influence green intentions and results.

Based on the conceptual framework, we have identified important areas of interest for future green IS studies and provide research questions that may be useful as a starting point for multiple streams of work.

4.2 Drivers of Green IS initiatives

As our framework shows, the organizational literature has explored factors that may influence initiation of green IS. However, few studies have examined technological factors and only one study (Bose & Luo, 2011) explicitly examines the technological factors related to specific kinds of green IS initiatives. As Corbett (2010) suggests, there are different kinds of green IS initiatives (e.g., collaboration technologies, data centers, innovative online services), and these will likely require different types of resources and support from organizations.

Q1a: *How do the different types of green IS initiative affect implementation and adoption?*

As researchers try to learn when and why organizations would initiate green IS, they must first clarify what green IS initiatives are in a specific context. It is possible that technological factors interact with environmental and organizational factors upon initiating green IS. One single factor, such as resource commitment, organizational structure, and so on, may be more important for some green IS initiatives but have no effect on others.

Q1b: *How do different technological factors affect implementation and adoption of green IS initiatives?*

Previous literature has examined strategies and practices in organizations to provide valuable understanding for how organizations may take advantage of green IS initiatives. However, few studies have looked at how organizations choose between different green IS initiatives and corresponding strategies or the impact of different green IS strategies on organizations. Classifying different initiatives and strategies would be a good starting point for understanding why organizations choose some initiatives and strategies and not others, results that could help practitioners in making their own decisions.

Q1c: *How are different green IS initiatives categorized?*

Green IS initiatives also hold important strategic implications for an organization's leadership and stakeholder relations. Organizations with more proactive strategies may try out innovative green IS initiatives and then choose to become green IS leaders, while those with a more passive strategy prefer to remain followers. As our framework shows, the technological factors of green IS can interact with strategies to influence green IS outcomes. Thus, we need future studies to examine how organizational strategies and leadership styles and capabilities affect the choice of different green IS initiatives.

Q1d: *Which strategies lead to successful adoption of different green IS initiative categories?*

4.3 Implementation and Adoption

Different green IS initiatives will have various operational implications for organizations. When choosing specific green IS initiatives, organizations may consider employee skills, organizational structures, and the IS in the organization. Data center redesign might not require employees to have a high level of skill or cause much change in the organizational structure for employees who do not directly interact with the data centers. On the other hand, adopting collaborative technologies such as virtual conferencing may require employees to acquire additional skills related to collaborative technologies, and such organizations would need to change certain structures (e.g., middle managers directly reporting to the CEO instead of senior managers). Thus, those organizations that feature certain skill sets or organizational structures/capabilities (e.g., absorptive capacity) may be more appropriate for some green IS initiatives than others. Future study is needed to examine the operational implications of such initiatives.

Q2a: *How does absorptive capacity influence the decision to implement Green IS initiatives?*

Another area that needs further examination is adoption of green initiatives at the individual level in organizations. As we discuss above, only one study fitted these characteristics, which examined accountants' attitudes toward an environmental accounting system. One reason for this gap may be that previous IS literature has extensively covered acceptance of technology by individuals; researchers may not view individual adoption of green IS initiatives as sufficiently important to examine. We suggest that researchers combine the technology acceptance literature with specific technological factors of green IS to understand how such technology, along with other relevant factors (e.g., individual attitudes toward sustainability), can influence the adoption of green IS initiatives. For example, green initiatives might not prevail in a company given strong internal resistance (e.g., change management issues).

Q2b: *What are the key individual factors that can help or hinder adopting green IS initiatives?*

4.4 The Effects of Green IS Initiative Adoption

While the literature reviewed has examined environmental, economic, and social impacts of green IS initiatives, the results have been mixed. At the organizational level, a majority of studies found positive outcomes, but some showed environmental outcomes to be negative and economic outcomes to be neutral. Such results reveal a possible disparity between the design and use of green IS initiatives.

Q3a: *Can agreement between the spirit and application of an initiative affect organizational outcomes?*

Only two studies examined the societal outcomes of green IS initiatives. Our framework highlights the fact that more studies are needed to determine whether green IS initiatives result in neutral or positive social outcomes and the circumstances that enable such an outcome. In this instance, case studies may be especially useful in order to delve into the process of green IS initiatives and identify the factors influencing various outcomes. These may then be reexamined in the context of other methods.

Q3b: *Does a positive societal outcome play an important role in green IS initiative implementation?*

Q3c: *What societal outcome factors play a significant role in green IS initiatives?*

Previously, the literature has viewed implementation of green IS initiatives as an end rather than a means; few studies have examined feedback or impacts of green IS initiatives on organizations. We argue that there may be a recursion between green IS initiatives and an organization that affect future decisions. van Osch and Avital (2010) describe how HP went through different stages of sustainable innovation. While the company's early green IS initiatives were responses to government regulations, HP eventually began to change its strategies and support regulations after adopting various initiatives. In this way, HP has become more proactive toward green IS initiatives, which had an impact on its subsequent initiation of green IS, leading to a competitive advantage. As our framework shows, future studies should examine the after effects of green IS initiatives on organizations. Conceptual frameworks must first be developed and tested using case study or survey methods.

Q3d: *How do the effects of previously adopted green initiatives affect the decision to adopt new initiatives?*

4.5 Cultural and Regional Differences

Regional and national policymakers play important roles in encouraging green IS initiatives. Policymakers not only establish corresponding regulations and enforce lowering carbon emissions but also may provide some lenience for those organizations who proactively adopt green IS initiatives and reduce energy consumption. The literature includes how regulations influence the adoption of green IS initiatives, but such studies mostly analyze the data from only one country or area. Future studies are needed to compare regional differences and examine how policymakers may influence the adoption of green IS initiatives from in different contexts. If possible, policymakers should try enacting certain initiatives themselves, such as redesigning a data center for their organizations, to model how companies can reduce energy consumption.

Q4a: *How do different governmental regulations impact the adoptions of green initiatives?*

Q4b: *How does the priority of a national government on environmental issues impact the adoption of green initiatives?*

4.6 Researching Green IS

Based on our review, we believe previous studies have paid limited attention to the development of theoretical frameworks surrounding the adoption of green IS. Knowing the different adoption phases that deal with policies and procedures on how best to manage a green IS project is critical for a successful implementation. First, the adoption framework can integrate the areas of studies posited and provide a more complete picture of green IS. In the three steps that Mann et al. (2009) proposes, determining external and internal factors may include factors identified during initiation, while determining the sophistication of the strategy, technology, and processes could draw on enterprise strategies and practices, and measuring sustainability of the proposed venture is consistent with outcomes. The adoption framework can also help scholars understand the later stages in the process, such as how green IS initiatives are implemented, how organizations change by implementing green IS initiatives, and how to balance green initiatives with other organizational initiatives. We suggest that future studies of green IS focus on developing adoption frameworks to see how the whole process of green IS unfolds.

Studies that have looked at general technology implementation may be helpful in providing a theoretical foundation for these adoption frameworks. Tornatzky and Fleischer's (1990) technology-organization-environment framework and Cooper and Zmud's (1990) IT implementation model may provide appropriate lenses. Future studies could also draw on DeSanctis and Poole's (1994) adaptive structuration theory, which they developed to understand advanced information systems (which could theoretically include green IS), to examine the holistic process of green IS. Thus, the framework created for our study could be the starting point of future studies to develop a theoretical framework for Green IS.

Q5a: *How does the process of green IS adoption ensue?*

Q5b: *What are the different theoretical lenses suitable for examining green IS adoption and implementation?*

Our review holds important implications for methods used in the green IS literature. Based on our review, various methods (case study, survey, secondary data, simulation, design science) have been used at different levels (technological, individual, organizational, industrial) to study this phenomenon, but limitations remain. The individual level has been relatively ignored, and few studies have analyzed the data in more than one country or region. In addition, few studies have used more than one method. Since green IS research is still immature, we suggest that future studies take a mixed-methods approach to gain a deeper understanding of green IS initiatives. Researchers could use case studies to identify the relevant factors influencing the outcome of green IS initiatives and test those factors using a survey. We would note that such mixed-methods studies are increasingly encouraged by the IS discipline, and a standard for guiding such studies has been introduced (Venkatesh, Brown, & Bala, 2013).

These suggestions may be challenging since not all organizations can adopt green IS initiatives and since data may be difficult to collect. Such approaches could employ a large project that includes multiple studies. We argue that, in planning research studies or projects, researchers may wish to use multiple methods and, whenever possible, collect data from different regions to gain a deeper understanding of green IS initiatives. Our review also shows that published studies have mostly taken a positivist or interpretative perspective. More studies are needed that follow a critical perspective to provide further insight into this phenomenon. Since green IS may be likened to corporate social responsibility (CSR), like

any CSR initiative, it is filled with contradictions. On one hand, implementing a green IS initiative could benefit an organization while, at the same time, be both costly and difficult to implement. Given these contrasts, a critical perspective could unearth some of the underlying causes and provide a guide on how to successfully address any contradictions. Note that researchers are calling for the use of critical perspectives in research involving CSR (e.g., Blowfield & Frynas, 2005).

Q5c: *Can critical social theory investigations into green IS provide knowledge about this phenomenon?*

Our review suggests that future green IS researchers may benefit from cross-disciplinary collaboration. Specifically, we identified such methods as surveys, experiments, case studies, design science, simulation, data mining, and conjoint analysis. Future IS researchers should consider collaborating with other disciplines who may be more familiar with these methods. By working with colleagues in other disciplines, additional methods or theoretical perspectives may be used to examine and understand green IS.

5 Conclusions

As the relevance of sustainability continues to increase in organizations, some have begun to consider how green IS initiatives can make businesses more environmentally friendly (Klassen & Vachon, 2003) and increase performance. Although the IS literature has started to consider different aspects of green IS, the overall body of research is immature. We reviewed both the scholarly and practical literatures to identify the limitations in each area. Based on these results, we provide high-level research agendas for future green IS studies. We do not offer definitive research questions but, rather, illustrate how researchers can examine and understand green IS. We hope this review will provide researchers with a foundation to study this important phenomenon.

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Appendix A: Academic Literature

Table A1. Academic Literature

Authors	Category	Level of analysis	Method	Philosophical perspective	Theory	Summary
AMCIS 2008						
Chaabane, Ramudhin, Paquet, and Benkaddour (2008)	Enterprise strategies and practices	Industry	Conceptual	Positivist	N/A	Introduce a model for green supply chain including carbon emission cost
Sayeed and Gill (2008)	Initiation; enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Organizations have different levels of using IT to support environmental sustainability
AMCIS 2009						
Erek, Schmidt, Zarnekow, and Kolbe (2009)	Enterprise strategies and practices	Organization	Empirical (qualitative interview)	Interpretive	N/A	Explore current environmental efforts in sustainable IS management
Hasan, Ghose, and Spedding (2009)	Enterprise strategies and practices	N/A	Conceptual	N/A	N/A	IS solutions for climate change agenda
Mann et al. (2009)	Initiation; adoption framework	Organization	Conceptual	Positivist	Theory of continuous improvement	Three step implementation framework for green IT
Sayeed and Gill (2009)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Organizations can leverage green IT implementation for strategic purposes by mobilizing dynamic resources
AMCIS 2010						
Cazier, Shao, and St. Louis (2010)	Outcomes	Individual	Empirical (experiment)	Positivist	N/A	Consumers are willing to pay the environmentally friendly company a modest premium
Corbett, Webster, Sayili, Zelenika, and Pearce (2010)	Initiation	N/A	Conceptual	Positivist	N/A	Three challenges of engaging green IS initiatives: dealing with different perspectives, setting the boundaries and context, and researching information
Dada, Staake, and Fleisch (2010)	Outcomes	Industry	Empirical (Monte Carlo)	Positivist	N/A	Capturing material parameters can decrease energy consumption
Hasan and Dwyer (2010)	Others	N/A	N/A	N/A	N/A	Propose a multifaceted approach to the climate change problem
Iacobelli, Olson, Merhout (2010)	Others	N/A	N/A	N/A	N/A	N/A
Kim and Ko (2010)	Enterprise strategies and practices	Organization	Empirical (data mining)	Positivist	Stakeholder theory; resource-	Several key variables can reasonably identify Green IT leaders

					based view	
Kuo and Dick (2010)	Initiation	Organization	Empirical (survey)	Positivist	N/A	The extent of green IT is influenced by management influences, bottom line considerations and normative legitimization pressures
McLaren, Manatsa, and Babin (2010)	Enterprise strategies and practices	Organization	Empirical (text mining)	Positivist	N/A	A new classification scheme for green IT initiatives
Schmidt, Ere, Kolbe, and Zarnekow (2010)	Initiation	Organization	Empirical (survey)	Positivist	N/A	Importance and uncertainty are main determinants
Seidel, Recker, Pimmer, and Brocke (2010)	Initiation	Organization	Empirical (case study)	Interpretive	N/A	Strategy definition, organizational support, motivation, and traceability can influence Green IS adoption
Tarafdar et al. (2010)	Initiation; outcomes	Organization	Empirical (case study)	Interpretive	Resource-dependence theory; knowledge transfer view	IT services provider can influence adoption of IT sustainability in client organizations
van Osch and Avital (2010)	Adoption framework; outcomes	Organization	Empirical (case study)	Interpretive	N/A	Illustrate how sustainable innovation has a greater potential for change and innovation
AMCIS 2011						
Benitez-Amado and Walczuch (2011)	Enterprise strategies and practices; outcomes	Organization	Empirical (secondary)	Positivist	Natural-resource-based theory	IT capability is an enabler of proactive ES
Corbett (2011)	Enterprise strategies and practices	Organization	Conceptual	Positivist	Information processing theory	Develop a model to improve the effectiveness of electricity demand management
Friedman, Dehler, Friedrich, Haack, and Schumann (2011)	Enterprise strategies and practices	Organization	Empirical (qualitative interview)	Interpretive	N/A	IS serve to provide better information and reveal hidden problems
Jung, Kim, and An (2011)	Outcomes	Organization	Empirical (survey)	Positivist	Resource-based view	Build relationships for information and knowledge showed significant effects on green management performances
Lee, Oh, Koo, and Sarkis (2011)	Initiation	Organization	Empirical (analytic network process)	Positivist	N/A	Green logistics can influence managers' strategic decisions for green supply chain management
Loeser Ere, Schmidt, Zarnekow, and Kolbe (2011)	Enterprise strategies and practices	Organization	Conceptual	Positivist	Resource-based view; Porter's competitive positioning	Develop the strategic green IT alignment framework
Nedbal et al. (2011)	Initiation	Organization	Empirical (case study)	Interpretive	Innovation diffusion theory	Develop a technology-organization-environment framework

Ruch Schmidt, Decker, and Kolbe (2011)	Initiation; enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Social business models have a potential in the search engine market
Ryoo, Koo, and Wati (2011)	Outcomes	Organization	Empirical (survey)	Positivist	Ecological modernization theory; complementarity theory	Green practice coordination have positive effect on environmental performance
Schiller and Merhout (2011)	Enterprise strategies and practices	Technology	Empirical (case study)	Interpretive	N/A	Introduce the practice of IT asset disposition services to maximize the value of the IT asset investment
Thies and Stanoevska-Slabeva (2011)	Enterprise strategies and practices	Technology	Conceptual (design science)	Positivist	N/A	Propose an innovative architecture artifact for inter-organizational environmental IS
Vazquez, Rocha, Dominguez, Morales, and Ahluwalia (2011)	Others	N/A	N/A	N/A	N/A	Develop themes of green-IS/IT research
Volkoff, Bertels, and Papania (2011)	Enterprise strategies and practices	Organization	Empirical (Case Study)	Interpretive	N/A	Try to understand how IS support an organization's strategic transition towards sustainability
Yim (2011)	Initiation; outcomes	Individual	Empirical (secondary)	Positivist	Feedback interventions theory	Energy competition has positive influence in reducing energy consumption for cohesive dorms
AMCIS 2012						
Califf, Lin, and Sarker (2012)	Others	N/A	N/A	N/A	N/A	Four categories of studies (design and implementation, adoption, and benefits) are identified
Corbett (2012)	Enterprise strategies and practices	Organization	Empirical (qualitative interview)	Interpretive	Institutional theory	Under institutional pressures, organizations may take a wait-and-see approach; organizations that perceive benefits become more engaged in transform smart grid
Corley, Cazier, and Vannoy (2012)	Outcomes	Individual	Empirical (experiment)	Positivist	N/A	General attitudes toward sustainability positively influence value congruence, which in turn positively influences consumer behavior
Flath, Ilg, and Weinhardt (2012)	Enterprise strategies and practices	Technology	Empirical (simulation)	Positivist	N/A	Develop relaxed and heuristic optimization approaches of Charging protocols
Goetzinger, Brandt, and Neumann (2012)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Apply green logistics to the facility location problem
Ijab, Molla, and Cooper (2012)	Initiation; enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Theory of practice	Green IS practices are used due to many internal and external factors

Kranz and Picot (2012)	Initiation	Individual	Empirical (Survey)	Positivist	Theory of planned behavior; technology acceptance model	Intention is influenced by secondary sources' influence and environmental concerns
Lei and Ngai (2012)	Initiation adoption framework	Organization	Conceptual	Positivist	Institutional theory; information processing theory; organization theory	Presents a theoretical framework on the assimilation of green IS
Opitz, Ere, Langkau, Kolbe, and Zarnekow (2012)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Process modeling and energy monitoring can help organizations become more environmentally sustainable
Qiu, Neumann, and Goetzinger (2012)	Enterprise strategies and practices	Technology	Empirical (simulation)	Positivist	N/A	Propose a position-aware-market to improve the utilization of less-than-truckload freight transportation
Simmonds and Bhattacharjee (2012)	Initiation; enterprise strategies and practices; adoption framework; outcomes	Organization	Empirical (case study)	Interpretive	Technology-organization-environment framework; IT implementation model	Identify factors that influence each stage of IT-based initiatives
Stolze, Semmler, and Thomas (2012)	Others	N/A	N/A	N/A	N/A	Provide a structured literature review of sustainability in business process management research
Strüker and van Dinther (2012)	Others	N/A	N/A	N/A	N/A	Identify underrepresented areas of smart grids
Thies and Stanoevska-Slabeva (2012)	Enterprise strategies and practices	Organization	Empirical (qualitative interview)	Interpretive	N/A	Extracts the critical success factors of sustainable business network
AMCIS 2013						
Benitez-Amado, Llorens-Montes, and Fernandez-Perez (2013)	Enterprise strategies and practices; outcomes	Organization	Empirical (secondary)	Positivist	Theory of operational and dynamic capabilities	Firm's proficiency to manage talent support a sustainable operations strategy and increase firm performance
Brandt (2013)	Enterprise strategies and practices; outcomes	Technology	Conceptual	Positivist	N/A	Provides an overview of automobile information systems
Erskine and Füstös (2013)	Enterprise strategies and practices; outcomes	Technology	Empirical (case study)	Interpretive	N/A	Outlines desktop virtualization's energy- and cost-savings

Grimm, Erek, and Zarnekow (2013)	Enterprise strategies and practices	Technology	Empirical (case study, simulation)	Interpretive, Positivist	N/A	Proposes a framework for Carbon Footprint of IT-Services
Krogstie, Ståhlbröst, Holst, Jelle, Kulseng, Gudmunds dottir, Braskus, and Olesen (2013)	Enterprise strategies and practices	Individual	Empirical (case study)	Interpretive	N/A	Describe an approach to develop an energy savings solution
Loeser (2013)	Others	N/A	N/A	N/A	N/A	Review the definitions of green IT and Green IS
Moeller, Krek, Loeser, and Zarnekow (2013)	Enterprise strategies and practices	Individual	Empirical (survey)	Positivist	N/A	Explore sustainability in the current COBIT 5 process reference model
Schmidt and Busse (2013)	Enterprise strategies and practices; outcomes	Technology	Empirical (Simulation)	Positivist	N/A	Evaluate the energetic impacts on current power plant capacities
Schödwell, Erek, and Zarnekow (2013)	Enterprise strategies and practices	Technology	Empirical (design science)	Positivist	N/A	Create a green performance measurement system
Strüker, Reichert, and Brenig (2013)	Enterprise strategies and practices	Industry	Conceptual	Positivist	Principal agent theory	Analyze the demand response business model with principal agent theory
ECIS 2009						
Butler and Daly (2009)	Initiation	Organization	Conceptual	Positivist	Institutional theory	Theorize how regulative, normative, and cultural-cognitive influences green IT adoption
Mary and Butler (2009)	Initiation	Organization	Conceptual	Positivist	Institutional theory	Develop theoretical propositions to examine the effect of institutional influences on environmental responsibility in organizations
ECIS 2010						
Capra, Formenti, Francalanci, and Gallazzi (2010)	Enterprise strategies and practices	Technology	Empirical (simulation)	Positivist	N/A	MIS applications layer impacts on the energy consumption
Schmidt, Schmidtchen, Koray, Kolbe, and Zarnekow (2010)	Outcomes	Individual	Empirical (Conjoint analysis)	Positivist	N/A	Green IT PCs positively influence market share.
Vykoukal (2010)	Initiation; outcomes	Organization	Empirical (survey)	Positivist	N/A	Grid technology can reduce the environmental impact of IT
ECIS 2011						

Alaraifi, Molla, and Deng (2011)	Initiation	Organization	Empirical (case study)	Positivist	Technology-organization-environment framework	Sensor IS context, data center context, organization context, and environment context factors are proposed to influence sensor IS assimilation
Bodenstein, Schryen, and Neumann (2011)	Outcomes	Technology	Empirical (simulation)	Positivist	N/A	Show the goodness of various approximations in terms of power savings
Boehm, Freundlieb, Stolze, Thomas, and Teuteberg (2011)	Adoption framework	Organization	Empirical (case study)	Interpretive	N/A	Conceptualizes a product model of IT infrastructure
Butler (2011)	Enterprise strategies and practices	Organization	Conceptual	Positivist	N/A	Develop a comprehensive, practice-oriented green IS framework
Curry, Hasan, ul Hassan, and Herstand (2011)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Propose an entity-centric approach to represent the environmental impact of business operations
Graml, Loock, Baeriswyl, Staake (2011)	Initiation	Individual	Empirical (experiment)	Positivist	Motivation-opportunity-ability model	Socio-psychological concepts are effective in supporting energy conservation behavior
Hjalmarsson and Lind (2011)	Enterprise strategies and practices; adoption framework	Organization	Empirical (case study)	Interpretive	N/A	Analyze essential actions performed to establish sustainable innovation
Kranz and Picot (2011)	Initiation	Individual	Empirical (survey)	Positivist	Theory of planned behavior	Environmental concerns and social influence are major determinants for green IS adoption
Schmidt and Kolbe (2011)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Contingency Theory	Organizations' suitable IT governance depends on contingency factors
Strüker, Weppner, and Bieser (2011)	Enterprise strategies and practices	Technology	Conceptual	Positivist	N/A	Propose non-regulated data exchange services
Thore et al. (2011)	Enterprise strategies and practices; outcomes	Technology	Conceptual (design science)	Positivist	N/A	How distributed RFID-based waste management information system can support electronic products recycling
Zampou and Pramatarı (2011)	Outcomes	Technology	Empirical (secondary)	Positivist	N/A	E-government services have different environmental profile
ECIS 2012						

Gimenez et al. (2012)	Outcomes	Organization	Empirical (secondary)	Positivist	N/A	IT-enabled coordination strengthens the impact of environmental practices on the environmental performance
Kossahl, Busse, and Kolbe (2012)	Others	N/A	N/A	N/A	N/A	Identify six main subfields for the energy informatics research
Takeda et al. (2012)	Outcomes	Organization	Empirical (case study, simulation)	Positivist, Interpretive	N/A	Promised benefits for suppliers depend on the development of information sharing and information quality
Thongmak (2012)	Initiation	Individual	Empirical (qualitative interview)	Interpretive	N/A	Most freshmen understand Green IT, but do not have a deep comprehension on their application
Zhang (2012)	Initiation	Organization	Empirical (case study)	Interpretive	Theory of planned behavior	Investigate how IT may facilitate green consumption
ECIS 2013						
Bradshaw and Donnellan (2013)	Enterprise strategies and practices	Scheme	Empirical (case study)	Interpretive	N/A	Use energy informatics to enhance the design of bike share schemes
Khanna and Venters (2013)	Enterprise strategies and practices	Project	Empirical (case study)	Interpretive	Complex adaptive systems theory	Intermediaries are important for the design of ICT systems in urban infrastructure prototyping.
Parmiggiani and Hepsø (2013)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Develop an integrated solution for real-time subsea environmental monitoring.
Stiel and Teuteberg (2013)	Adoption framework	Technology	Conceptual (design science)	Positivist	N/A	Suggests a framework for life cycle assessment in sustainable IS management
ICIS 2009						
Chen, Watson, Boudreau, and Karahanna (2009)	Initiation	Organization	Empirical (survey)	Positivist	Institutional theory ; natural resource-based View	Mimetic and coercive pressures significantly drive Green IS and IT adoption.
Hedwig, Malkowski, and Neumann (2009)	Enterprise strategies and practices; outcomes	Technology	Empirical (simulation)	Positivist	N/A	The prediction of future workload allows about 25% saving of total energy cost
Molla, Cooper, and Pittayachawan (2009)	Initiation	Organization	Empirical (survey)	Positivist	N/A	Develop and test G-readiness model, which include attitude, policy, practice, technology and governance
ICIS 2010						
Corbett (2010)	Others	N/A	N/A	N/A	N/A	Review current literature and develop theoretical propositions

Mithas, Khuntia, and Roy (2010)	Initiation; outcomes	Organization	Empirical (survey)	Positivist	Belief-action-outcome theory	Top management commitment, perceived importance have an important role; Implementation is positively related with energy saving and profit impact
ICIS 2011						
Loock, Staake, and Landwehr (2011)	Outcomes	Individual	Empirical (experiment)	Positivist	Social presence theory	Descriptive and injunctive normative feedbacks delivered by websites have significant effects on energy consumption
Tan, Pan, and Zuo (2011)	Initiation; enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	How green leadership can be achieved, which facilitate collective green IT initiatives
ICIS 2012						
Dorsch and Häckel (2012)	Enterprise strategies and practices	Technology	Empirical (design science, simulation)	Positivist	N/A	Reasonable benefits of excess capacity markets concerning the economic and environmental perspective are found
Fradley, Troshani, Rampersad, and De lonno (2012)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Organizing vision	Employ the organizing vision framework for ICT innovations to examine green IS development
Hedman, Henningsson, and Selander (2012)	Adoption framework; outcomes	Organization	Empirical (case study)	Interpretive	N/A	Analyze the process by which a firm transforms towards ecological effectiveness
Hovorka and Corbett (2012)	Others	N/A	N/A	N/A	N/A	Develop a trans-disciplinary framework for IS sustainability research
Loeser, Erekan, and Zarnekow (2012)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Identify four distinct green IS strategies
Loock, Landwehr, Staake, Fleisch, and Pentland (2012)	Enterprise strategies and practices	Individual	Empirical (experiment)	Positivist	Theory of normative conduct; social learning theory; social identity theory	Reference groups close to the energy consumer are suggested
Nanath and Pillai (2012)	Enterprise strategies and practices	Organization	Empirical (secondary)	Positivist	N/A	Sustainable culture and business process can influence the sustainability of green IT
Nishant, Teo, Goh, and Krishnan (2012)	Outcomes	Organization	Empirical (secondary)	Positivist	Resource-based View	Environmental performance has a positive effect on organizational performance
von Mohrenfels and	Initiation	Individual	Empirical (experiment)	Positivist	N/A	Extended packaging can be used to heighten the brand perception

Klapper (2012)						
Watson, Lind, and Haraldson (2012)	Others	N/A	N/A	Critical	N/A	Propose a sustainability dominant logic
ICIS 2013						
Brandt, Feuerriegel, and Neumann (2013)	Enterprise strategies and practices	Technology	Empirical (simulation)	Positivist	N/A	Introduced an IS artifact to utilize synergies between electric vehicles and photovoltaic panels.
Busse, El Khatib, Brandt, Kranz, and Kolbe (2013)	Initiation	Individual	Empirical (survey)	Positivist	Theory of planned behavior; value belief norm theory	Investigate the effect of cultural factors on the adoption of eco-innovations.
PACIS 2007						
Elliot (2007)	Others	N/A	N/A	N/A	N/A	Develops research taxonomy for the environmental sustainability of ICT.
PACIS 2008						
Elliot and Binney (2008)	Initiation; enterprise strategies and practices; adoption framework; outcomes	Organization	Empirical (case study)	Interpretive	N/A	A development framework for corporate capabilities in ICT environmental sustainability
Huang (2008)	Adoption framework	Technology	Conceptual	Positivist	N/A	SSDLC is proposed that put emphasis on sustainability
PACIS 2009						
Molla (2009)	Enterprise strategies and practices	Organization	Empirical (survey)	Positivist	N/A	A green IT-reach-richness matrix to classify green IT strategies and initiatives
Sarkar and Young (2009)	Initiation	Organization	Empirical (case study)	Interpretive	N/A	Attitudes are transformed into action when a sound model exists, with designed long-term awareness programs
Vykoukal et al. (2009)	Outcomes	Organization	Conceptual	Positivist	Resource-based view	Green IT has economic and ecological benefits; increases the companies' competitiveness
PACIS 2010						
Ijab et al. (2010)	Adoption framework	Organization	Conceptual	Critical	Lifecycle framework	Green IS lifecycle framework is proposed
Lee and Casalegno (2010)	Enterprise strategies and practices	Organization	Conceptual	Positivist	N/A	Key dimensions are suggested to design new business models for sustainability
Schlieter, Juhirsch, and Niggemann (2010)	Enterprise strategies and practices; outcomes	Organization	Empirical (case study)	Interpretive	N/A	Present a reference model-based method to serve for setting up energy management systems
PACIS 2011						
Alaraifi, Molla, and Deng	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Develops a characteristics-based framework for describing data center IS

(2011)						
Chang (2011)	Initiation	Individual	Empirical (survey)	Positivist	Organizational reform theory	Organizational culture, individual demands and value are important to influence accountants' attitudes.
Erek, Loeser, Schmidt, Zarnekow, and Kolbe (2011)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Propose a strategic green IT alignment framework and identify four distinct green IT strategies
Molla and Abareshi (2011)	Initiation	Organization	Empirical (survey)	Positivist	Theory of organizational motivation	Eco-efficiency and eco-effectiveness motives influence the adoption green IT initiatives;
Nishant, Teo, and Goh (2011)	Outcomes	Organization	Empirical (secondary)	Positivist	Resource-based view	There are positive relationships between the green IT announcements and the cumulative abnormal returns
PACIS 2012						
Cooper and Molla (2012)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Theory of absorptive capacity	Develop a model for green IT absorptive capacity
Kurnia, Mahbubur, and Gloet (2012)	Enterprise strategies and practices	Organization	Conceptual	Positivist	N/A	Identify the role of IT in supporting sustainable supply chain management practices
Nishant, Teo, and Goh (2012)	Outcomes	Organization	Empirical (secondary)	Positivist	Ecological modernization theory	Per capita energy efficiency research and development investment is negatively associated with per capita emissions
PACIS 2013						
Abdul Rahim and Abdul Rahman (2013)	Enterprise strategies and practices; outcomes	Organization	Empirical (survey)	Positivist	Natural-resource-based view	Proposing an integrative framework to examine on IS resources and capabilities
Chowdhury, Dewan, and Quaddus (2013)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Stakeholder theory	Develop a comprehensive sustainable supply chain management framework in the context of RMG supply chain
Dewan, Biswas, Chowdhury, and Quaddus (2013)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Stakeholder theory	Uses an analytic hierarchy process integrated quality function deployment approach to show how to achieve sustainability of e-business.
Dewan, Biswas, Chowdhury, and Quaddus (2013)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	Stakeholder theory	Shows a sustainable e-business model
Joo and Kim (2013)	Initiation	Individual	Empirical (qualitative interview)	Interpretive	N/A	Examines factors affecting the adoption smart grid technology

Koo, Chung, and Lee (2013)	Initiation	Individual	Empirical (survey)	Positivist	Motivation theory; reference group theory	Investigate the determinants of behavior intention to use green IT devices
Lei and Ngai (2013)	Initiation	Organization	Empirical (survey)	Positivist	N/A	Investigate how organizational factors affect organizational decision makers' intention to adopt green IT.
Lei and Ngai (2013)	Others	N/A	N/A	Positivist	Technology-organization-environment Theory	Provides a literature review of the adoption of green IT.
Lin, Yang, Hsu (2013)	Enterprise strategies and practices	Organization	Empirical (Content Analysis)	Positivist	Institutional theory	Applies topology of legitimacy to understand actors' strategies of green IS.
Nishant, Teo, and Goh (2013)	Outcomes	Organization	Empirical (secondary data)	Positivist	Natural resource-based view	Examine how green IS can influence competitive advantage.
Nishant, Teo, and Goh (2013)	Outcomes	Organization	Empirical (secondary data)	Positivist	Resource-based view	Examine how sustainable IT practices influence environmental performance.
Yang, Li, and Tan (2013)	Initiation	Organization	Empirical (case study)	Interpretive	N/A	Suggest three type of drivers for organizations to adopt Green IT.
Business and Society						
Jenkin, McShane, and Webster (2011)	Initiation enterprise strategies and practices	Organization	Empirical (qualitative interview)	Interpretive	N/A	Organizations are in the early stage of awareness and adoption of green IS
Communications of the Association for Information Systems						
Dedrick (2010)	Others	N/A	N/A	N/A	N/A	Review previous literature and present a model of IT investment and carbon productivity
Molla, Cooper, and Pittayachawan (2011)	Initiation	Organization	Empirical (survey)	Positivist	Resource-based view; natural resource-based view	Identify five components of Green IT-readiness and provides an instrument
Information and Organization						
Jenkin, Webster, and McShane (2011)	Others	N/A	N/A	N/A	N/A	Review the existing green IT/IS literature and identify important research gaps
International Journal of e-Business Management						
Molla, Pittayachawan, Corbitt, and Deng (2009)	Initiation	Organization	Empirical (survey)	Positivist	N/A	The disposal of IT in an environmentally friendly manner is the most relevant concern about Green IT
JSIS						
Bengtsson and Ågerfalk (2011)	Initiation	Organization	Empirical (case study)	Interpretive	Actor network theory	Successful implementation requires a thorough understanding of organizational routines and standards
Bose and Luo (2011)	Initiation	Organization	Conceptual	Positivist	Technology-organization-environment framework;	An integrative framework focusing on initiation via virtualization

					process- virtualization- theory framework	
Butler (2011)	Initiation	Organization	Empirical (case study)	Interpretive	Institutional theory	Explain how green IS can support sense-making, decision making and knowledge sharing and creation around the design and manufacture of green IT
Dao, Langella, and Carbo (2011)	Outcomes	Organization	Conceptual	Positivist	Resource-based view	Integrate human, supply chain, and IT resources and call for initiatives beyond energy consumption reduction
DesAutels and Berthon (2011)	Outcomes	Technology	Empirical (secondary)	Positivist	N/A	As manufacturers comply with sustainability standards, the cost will rise
Petrini and Pozzebon (2009)	Enterprise strategies and practices	Organization	Empirical (case study)	Interpretive	N/A	Business intelligence is important to help organizations implement and monitor sustainable practices
Pitt, Parent, Junglas, Chan, and Spyropoulou (2011)	Others	N/A	N/A	N/A	N/A	A research agenda for to study the use of smartphones in search of a sustainable information technology agenda
Watson, Boudreau, Chen, and Sepúlveda (2011)	Initiation	Organization	Empirical (case study)	Interpretive	N/A	Need an innovation orientation to understand consumers' physical and informational needs
Zhang, Liu, and Li (2011)	Enterprise strategies and practices	Technology	Conceptual (design science)	Positivist	N/A	Model the rationality behind IT system design and understand the role of the environment related considerations
International Journal of Technology Management						
Haigh and Griffiths (2008)	Outcomes	Organization	Empirical (case study)	Interpretive	N/A	IS implementation can affect the environmental sustainability of service-oriented operations positively or negatively; the operational practices of staff may also influence the environmental impact
MISQ						
Melville (2010)	Others	N/A	N/A	N/A	Belief-action-outcome framework	Develop a research agenda on IS innovation for environmental sustainability
Watson, Boudreau, and Chen (2010)	Others	N/A	N/A	N/A	N/A	Advocate a research agenda to establish a new subfield of energy informatics
Elliot (2011)	Others	N/A	N/A	Positivist	N/A	Develop a framework for IT-enabled business transformation

Appendix B: Practical Literature

Table B1. Practical Literature

Journal/ conference	Authors	Topic/research question	Category	Summary
<i>CACM</i>	CACM Staff (2007)	Mainframe power usage monitor	Initiation	IBM will report power consumption on servers
<i>CACM</i>	CACM Staff (2007)	Greener pastures	Initiation	Environmental pressures may force organizations to find greener way of doing the business.
<i>CACM</i>	Kurp (2008)	News about green computing	Initiation	Green computing movement mainly focuses on data centers
<i>CACM</i>	Albers (2010)	Energy-Efficient Algorithms	Enterprise strategies and practices	Discusses energy-efficient algorithms decreasing energy consumption.
<i>CACM</i>	Brown and Reams (2010)	Power Management	Enterprise strategies and practices	proposes to implement energy-optimization mechanisms within systems software
<i>CACM</i>	CACM Staff (2010)	Bell Labs and Networks' Energy Usage	Outcomes	Bell Labs launched Green Touch to make networks 1,000 times more energy efficient
<i>CACM</i>	Geller (2010)	Sensor networks of power consumption	Enterprise strategies and practices	Sensors and communications hardware can be used to monitor and control devices
<i>CACM</i>	Greengard (2010)	Garbage tracking	Enterprise strategies and practices	Propose a removal-chain system to slash landfill requirements
<i>CACM</i>	Woods (2010)	Design of data center cooling systems	Enterprise strategies and practices	Carefully design air's convective flow patterns with the use of a hybrid heat-exchange/refrigeration system can reduce energy consumption.
<i>CACM</i>	Andersen, Franklin, Kaminsky, Phanishayee, Tan, and Vasudevan (2011)	A fast array of wimpy nodes	Enterprise strategies and practices; adoption framework; outcomes	Presents FAWN's principles and describes its design and implementation.
<i>CACM</i>	Goth (2011)	processor power management	Enterprise strategies and practices	different ways to manger processors' power consumption
<i>CACM</i>	Xu and Li (2011)	A new paradigm of IT	Enterprise strategies and practices	Computing for the masses is needed to dealt with the challenges facing IT
<i>CACM</i>	Kostyk and Herkert (2012)	Security and access of smart grid	Enterprise strategies and practices	Smart grid is a sociotechnical system that go beyond grid engineering
<i>CACM</i>	Mone (2012)	Data center redesign	Enterprise strategies and practices	Leading companies have begun revising the way to design, maintain, and monitor data centers
<i>CACM</i>	Ramchurn, Vytelingum, Rogers, and Jennings (2012)	Smart grid	Enterprise strategies and practices	Summarize the challenges related to smart grid.
<i>CACM</i>	Watson, Corbett, Boudreau, and Webster (2012)	Information strategies	Enterprise strategies and practices	Propose strategies of information for sustainability
<i>CIO</i>	Kirk (2007)	Green IT initiatives in Microsoft	Initiation	Microsoft will launch best practices for running data centers
<i>CIO</i>	Overby (2007)	Introduction of new technology into data center	Outcomes	VistaPrint expects to save nearly \$500,000 and cut carbon emissions by several hundred tons

<i>CIO</i>	Varon (2007)	Benefit of green IT initiatives	Outcomes	Businesses can benefit from Green IT initiatives in various ways
<i>CIO</i>	Walsh (2007)	Corporate sustainability initiatives	Initiation; enterprise strategies and practices	IT plays a key role in supporting sustainability initiatives
<i>CIO</i>	West (2007)	Data center management	Approaches and strategies	Good practices for managing data center costs
<i>CIO</i>	Beach (2008)	Talk with Michael Dell about green strategy	Initiation; Outcomes	Make green a strategic pillar of the firm
<i>CIO</i>	Burnham (2008)	Green IT budgets getting cut	Initiation	Economic crashes are bad for green IT
<i>CIO</i>	CIO Staff (2008)	Intel designed green-certified buildings	Outcomes	The building should save about \$ 235,000 annually
<i>CIO</i>	CIO Staff (2008)	Green initiatives decision	Initiation	Many IT executives still lag in buying energy-efficient products
<i>CIO</i>	Sacco (2008)	Green ranking	Initiation	Sony Ericsson ranks the first
<i>CIO</i>	Shah (2008)	Vendors and legislative mandate for recycling	Enterprise strategies and practices	Vendors begin to push through a legislative mandate for recycling
<i>CIO</i>	Varon (2008)	Green IT and businesses	Initiation; enterprise strategies and practices	Organizations begin to adopt green IT initiatives
<i>CIO</i>	Ricknäs (2009)	Greener profits	Outcomes	European companies net 2% profits
<i>CIO</i>	Swanborg (2009)	Raytheon' Green IT strategy	Outcomes	Raytheon project showed benefits for company and environment
<i>CIO</i>	Brandon (2010)	Fuel cells and data center	Initiation; outcomes	Fuel cells are highly environmentally friendly, but can also be costly
<i>CIO</i>	CIO Staff (2010)	Sustainability initiatives from CIOs	Enterprise strategies and practices; outcomes	Green IT initiatives can improve companies' performance in various ways
<i>CIO</i>	Nash (2010)	Sustainability requirements	Enterprise strategies and practices	Businesses require IT vendors to prove sustainability claims
<i>CIO</i>	Varon (2010)	Green product strategies	Enterprise strategies and practices	IT helps support green product strategies
<i>CIO</i>	Varon (2010)	Sustainability and CIO	Enterprise strategies and practices	CIOs are involved in Green IT initiatives
<i>CIO</i>	Varon (2010)	Systems to support sustainable decisions	Enterprise strategies and practices; outcomes	Systems are needed to report energy usage so companies can make better decisions
<i>CIO</i>	Varon (2010)	Green metrics	Outcomes	Green metrics helps companies more sustainable
<i>CIO</i>	Varon (2011)	sustainability analytics usage	Enterprise strategies and practices; outcomes	Saab uses eco-footprint management to integrate information about energy consumption and carbon emissions.
<i>CIO</i>	Varon (2011)	IT-enabled business practices	Enterprise strategies and practices; outcomes	Three organizations use IT-enabled business practices to advance sustainability
<i>CIO</i>	Varon (2011)	internally focused initiatives and payoff	Enterprise strategies and practices; outcomes	Organizations' returns from sustainability come from integrating these initiatives a part of their business strategies.
<i>CIO</i>	Varon (2011)	PC donation	Enterprise	Donating PC can help communities and

			strategies and practices; outcomes	reduce e-waste disposal costs.
<i>CIO</i>	Varon (2011)	Green thinking training	Enterprise strategies and practices	Organizations train their employees to think green.
<i>CIO</i>	Rowh (2012)	Security for smart grid	Enterprise strategies and practices	A lack of security standards makes smart grids quite vulnerable.
<i>PC World</i>	Rebbapragada (2007)	Tips on a "green" office	Enterprise strategies and practices	How to save energy and money by good "green" practices
<i>PC World</i>	Brinson (2008)	ways to reduce carbon footprint	Enterprise strategies and practices	steps to shrink the carbon footprint in home
<i>PC World</i>	Perenson (2009)	Reduced power consumption in internal hard drives	Outcomes	Saving money and saving power
<i>PC World</i>	Brandrick (2010)	Green PCs	Enterprise strategies and practices	Different ways to green PCs
<i>IT Professional</i>	Aronson (2008)	Benefits of Green IT	Enterprise strategies and practices; outcomes	IT can positively impact energy use, and lessen its negative impacts.
<i>IT Professional</i>	Feng, Feng, and Ge (2008)	Energy-efficient supercomputing	Initiation; Enterprise strategies and practices	different approaches to improve energy efficiency in supercomputers
<i>IT Professional</i>	Krikke (2008)	e-waste recycling	Initiation; Enterprise strategies and practices; outcomes	e-waste recycling industry
<i>IT Professional</i>	Murugesan (2008)	How to take advantage of Green IT	Initiation; Enterprise strategies and practices; outcomes	Benefit, holistic approach to green IT, how to use IT, enterprise green IT strategy
<i>IT Professional</i>	Bianzino, Raju, and Rossi (2011)	The evaluation of end-user PCs browsing the Web	Enterprise strategies and practices	Reveals the unnecessary power expenditures of tabbed browsing
<i>IT Professional</i>	Bose and Yan (2011)	An analysis of 13 cases on RFID's use in green projects	Initiation; Enterprise strategies and practices; outcomes	RFID is potential not only to enhance environmental sustainability but also to reduce costs and generate revenue
<i>IT Professional</i>	Donnellan, Sheridan, and Curry (2011)	a framework for systematically assessing and improving sustainable ICT capabilities	Enterprise strategies and practices; adoption framework	The framework can help organizations assess the maturity of their SICT capability and systematically improve capabilities in a measurable way
<i>IT Professional</i>	Harmon and Demirkan (2011)	Green IT strategies beyond energy savings and regulatory compliance	Enterprise strategies and practices; adoption framework	A roadmap for IT managers to realize different benefit of Green IT
<i>IT Professional</i>	Hedman and Henningson (2011)	Three strategies for green IT	Enterprise strategies and practices	Storefront focuses on external presentation, tuning involves simple changes for improved efficiency, and redesign reinvents the company to leverage green IT's potential
<i>IT Professional</i>	Jain, Benbunan-Fich, and	The balanced scorecard from	Enterprise strategies and	Explore how IT can contribute to sustainability performance

	Mohan (2011)	sustainability perspective	practices; outcomes	
<i>IT Professional</i>	Unhelkar (2011)	Trend of green IT	Enterprise strategies and practices	Green IT's trend: reduce carbon emission, enterprise carbon reduction, and collaborative green IT
<i>MISQE</i>	Babin and Nicholson (2009)	Challenges for corporate social and environmental responsibility	Enterprise strategies and practices	Identify four key trends in the corporate social and environmental responsibility knowledge and capabilities and provide guidelines
<i>MISQE</i>	Weiss (2009)	UPS experience with Green IT	Enterprise strategies and practices	Collaboration between IT and other business units at UPS to implement "sustainable practices"
<i>MISQE</i>	Watson, Boudreau, Li, and Levis (2010)	Telematics at UPS	Enterprise strategies and practices; adoption framework; outcomes	Present four lessons from UPS's telematics project and the Energy Informatics Framework
<i>MISQE</i>	Curry, Guyon, Sheridan, and Donnellan (2012)	Intel's sustainability initiatives	Enterprise strategies and practices; outcomes	Identify four lessons from Intel's initiatives
<i>MISQE</i>	Park, Eo, and Lee (2012)	Green IT maturity	Enterprise strategies and practices; adoption framework	Present a framework to assess green IT maturity
<i>MISQE</i>	van Heck, van Baalen, van der Meulen, and van Oosterhout (2012)	Green initiatives in Microsoft NL	Enterprise strategies and practices	Develop guidelines to move toward a mobile and green high performance workforce
Online	Mines (2008)	Strategies of green IT supplier	Adoption framework	Phases of green IT initiation

Appendix C: Assessment of Articles by Literature and Outlets

To assess papers by category, we examined the papers by year to identify the trends in green IS publication. Table C-1 summarizes each category by year, while Table C-2 summarizes the distribution of papers by year in each outlet. We listed only the main outlets with more than two papers in order to lower the variation. From the results outlined in Table C-2 and Figure C-1, the scholarly literature showed a different pattern than the practical literature. For the scholarly literature, the number of papers increased from 2007 to 2011. In the practical literature, the number of papers fluctuated, increasing from 2007 to 2008, decreasing in 2009 before reaching a peak in 2010 and 2011. For each outlet, the pattern was similar: in the scholarly literature, the overall number of papers published increased over time, but, in the practical literature, published papers fluctuated in number.

Table C1. Trend of Papers by Category

Category	Number of Papers by Year							TOTAL
	2007	2008	2009	2010	2011	2012	2013*	
Practical literature								
Initiation	4	8	0	1	1	0	-	14
Enterprise Strategies and Practices	3	7	2	11	16	8	-	47
Adoption Framework	0	1	0	0	4	1	-	6
Outcomes	2	6	3	6	7	1	-	25
Academic Literature								
Initiation	0	2	7	7	26	7	5	54
Enterprise Strategies and Practices	0	3	6	5	19	15	18	66
Adoption Framework	0	2	1	2	2	3	1	11
Outcomes	0	2	2	8	11	8	7	38
Other (e.g., review)	1	0	0	6	4	6	2	19
TOTAL	10	31	21	46	90	49	28	275

* Conference proceedings from 2013 are included.

Table C2. Distribution of Papers by Year (2007–2012)

Major Journal/ Conference	Number of Papers by Year						Total
	2007	2008	2009	2010	2011	2012	
Practical literature							
CACM	2	1	0	6	3	4	16
CIO	5	7	2	7	5	1	27
PC World	1	1	1	1	0	0	4
IT Professional	0	4	0	0	7	0	11
MISQE	0	0	2	1	0	3	6
Total	8	13	5	15	15	8	64
Academic Literature							
AMCIS	0	2	4	12	14	14	46
ECIS	0	0	2	3	12	5	22
PACIS	1	2	3	3	5	3	17
ICIS	0	0	3	2	2	10	17
JSIS	0	0	1	0	8	0	9
MISQ	0	0	0	2	1	0	3
Total	1	4	13	22	42	32	114

* *IT Professional* published a special issue in 2011; *JSIS* published a special issue in 2011.

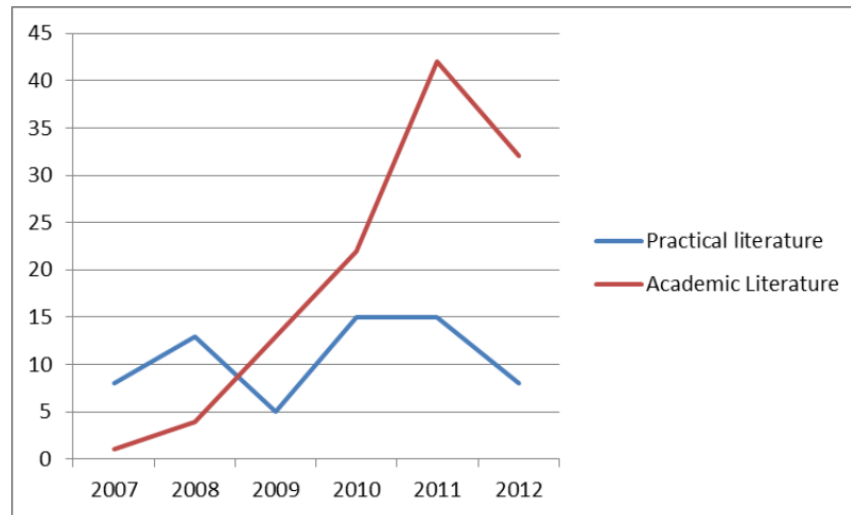


Figure C1. Distribution of Papers by Year (2007–2012)

Please note that different conferences offer different trends. For AMCIS and ICIS, the number of papers published increased dramatically in 2011 and 2012. On the other hand, ECIS showed a huge jump in 2011 and then dropped off again in 2012. For PACIS, the number of papers remained stable but relatively low. These results indicate that, while green IS has received more attention, especially in North America and Europe, researchers from the Pacific-Asia region have not given it as much attention.

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