Unpacking Green IS: A Review of the Existing Literature and Directions for the Future

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Abstract Green IS is one of the latest manifestations in the realm of sustainable business practices. The decisions surrounding Green IS implementation strategies, policies, and tools provide compelling challenges for organizations. As practitioners have been highly interested in this topic for a while (known as Green IT), there has also been a recent growing interest in Green IS within the IS academic community. In this chapter, we conduct a systematic and comprehensive review of both the practitioner and academic literatures surrounding Green IS. Specifically, our review includes articles published in the IS academic Senior Scholar's Basket of Journals, hybrid journals such as *Communications of the ACM*, *IEEE Software*, and *MIS Quarterly Executive*, and practitioner outlets such as *CIO* magazine and *PC World*. Through this review, we identify the main streams of Green IS-related studies that have been undertaken within both practice and academia, and offer a holistic picture of the current state of research/interest in Green IS. We then identify the overlaps and differences between the two sides (that is, academia and practice) in an attempt to unearth noticeable similarities/gaps between both perspectives. Finally, we not only identify the trends in Green IS research, but also provide academic scholars interested in Green IS more focused directions on the specific research questions to address with respect to Green IS.

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1 Introduction

With the growing awareness of environmental issues such as global climate change, organizations increasingly realize the importance of sustainability. One definition of sustainability is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED [World Commission on Environment and Development], 1987, p. 43). Therefore, sustainability is a complex phenomenon that includes environmental, economic, and social dimensions (Kleindorfer, Singhal, & Wassenhove, 2005; Porter & Kramer, 2006). The essence of sustainability is that these three dimensions need to be addressed simultaneously rather than being viewed as trade-offs or with one of the dimensions superior to the other two. One example of sustainable initiatives is from IBM. On May 11, 2007, IBM launched a $1 billion-a-year service initiative to build and redesign data centers consuming less energy. Later, as an extension of its Project Big Green, IBM launched another program to allow mainframe customers to monitor their energy consumption in real time (CACM Staff, 2007a).

Sustainability can be traced back almost as far as a researcher would care to go. Perhaps the important question is what the motivation and the degree of emphasis at varying times in history were behind what are often called "green practices". Some in the "green movement" would suggest that "green" is a reaction to the excesses resulting from the development of Western societies and the waste generated from that development. Rather than continuing to emphasize growth at any cost, the green movement suggested that the relationship between humans and their environment must not be taken for granted. Gradually, the ideas of sustainability evolved into what are now almost mainstream acceptance and usage by individuals and organizations.

As sustainability became more and more common in organizations at all levels, oil prices reached $100 a barrel in January 2008. A "wake-up call" as popular usage has it, must have been heard in information technology (IT) departments around the developed world. As firms reacted individually to the challenge of escalating energy prices and other related impacts to their bottom lines, many also found themselves facing increased pressure to reduce their carbon footprint, emissions, or whatever other metric of choice was the focus for variety of regulatory, political, and social actors in their respective domains. Even firms that had not been adopting green practices as a consequence of a commitment to environmental and sustainable operations as part of their business, found themselves facing a whole new reality. They were now going to have to look at every aspect of their business with a "green lens" or face the consequences. Therefore, firms increasingly recognize the importance of sustainability. Green business practices, even if that means just basic recycling practices, can have a significant effect on a firm's bottom line. Besides, companies have a variety of choices regarding what kind (and what amount) of sustainable investments to make.

Given the size of most firms' IT investments, it is not surprising that Green IT is gaining in relevance and that the practitioner community has begun to pay attention

to it. Practitioners have proposed Green IT as a technological solution to support environmentally friendly business practices. Murugesan (2008) suggests that Green IT is:

> "the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment. Green IT also strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities (pp. 25–26)".

Green IT was recognized as the most important strategic technology for 2008 (Thibodeau, 2007). In December 2009, Copenhagen, Denmark hosted the United Nations Climate Change Conference, and Green IT was a topic of focus for the 192 members of the United Nations.

Green IT could be seen as just a way to reduce what McKinsey research (2008) estimates will be 3% of worldwide greenhouse gas (GHG) emissions in 2020. The Environmental Production Agency (EPA) told the US Congress in 2007 that data centers in the U.S. used 61 billion kilowatt-hours in 2006 (1.5% of all the power used) at a cost of $4.5 billion (InformationWeek, 9/2007). Perhaps even more important, both the EPA report and McKinsey (among others), says IT could reverse this trend significantly by enabling practices such as telecommuting and productive (non-wasteful) use of energy.

Business researchers have examined sustainability for decades from the perspectives of marketing (Belk, Painter, & Semenik, 1981), operations (Corbett & Kirsch, 2001), and management (Gladwin, 1993; Shrivastava, 1994). Recently, information systems (IS) literature also began to realize the importance of sustainability, and proposed the concept of "Green IS" to better understand the role of IS in dealing with sustainability (Melville, 2010; Watson, Boudreau, & Chen, 2010). For example, the International Conference on Information Systems (ICIS) hosted a submission track for Green-focused papers for the first time in 2009. Yet, there seems to be a lack of direction in term of the specific topics and approach to focus on in term of Green IS.

Boudreau, Chen, and Huber (2007) summarize the key difference between IT and IS: "An information technology (IT) 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." This differentiation applies to Green IT and Green IS as well.

To understand and study sustainability comprehensively, we must consider that Green IS involves power consumption and management, manufacturing practices, data center design and operations, recycling and end-of-life concerns for computer equipment, total cost of ownership issues, both micro and macro-economic issues, systems performance and efficient systems use, and environmental, social, and ethical practices relating to IT acquisition, use, and disposal. In short, we conceptualize Green IS as a multi-faceted phenomenon that is comprised of the ideas described as well as having the potential to include other facets not specifically mentioned.

Green IS has a greater potential in research and practice than Green IT because it tackles a much larger problem: it can make entire systems more sustainable compared to just reducing the energy required to operate information technologies (Boudreau et al., 2007). Therefore, our objective for this chapter is to offer specific research directions for the topic of Green IS for IS researchers. In order to give more focused directions, we assess the current state of Green IS studies by reviewing the current literature about Green IS. Given the debate in IS about being both rigorous and relevant (Benbasat & Zmud, 1999; Davenport & Markus, 1999; Lee, 1999; Lyytinen, 1999), in this chapter we review practitioner as well as academic literature so that we can get a clear picture of the topics discussed in Green IS literature from both sides and give more focused directions in terms of addressing topics valuable to Green IS in a rigorous as well as relevant way. Based on the results of our review, we identify the main areas of the published Green IS research and present a holistic picture of the current state of research/interest in Green IS. We then compare the overlaps and differences between practitioner and academic literature. Finally, we identify trends in Green IS research as well as provide academic scholars with more focused directions in terms of addressing topics valuable to Green IS in a vigorous as well as relevant way.

Given the breadth of the concept of Green IS, and owing to the research being in its infancy, there is a noticeable level of uncertainty about what should be examined with respect to Green IS. Hence, our objective in this chapter is to provide research directions on Green IS. Given that most studies we identified in the literature focus on Green IT, we first suggest that future studies should direct their focus on the more encompassing phenomenon of Green IS. This is because we conceptualize Green IT as being a part of Green IS. The research questions that we offer for future study of Green IS span pre-adoption-related decisions: *What motivates a company to decide to begin Green IS initiatives?*; the post-adoption decision: *What are the impacts of Green IS initiatives?*; and the adoption/implementation process itself: *How should the firm manage the process of Green IS adoption?*.

The rest of the chapter is organized as follows: first, we define the concept of Green IS, and give a brief introduction of eco-goals of Green IS. We then review both practitioner and academic literature and present the results. Next, we identify the overlaps and differences between two sides as well as evaluate the current status of Green IS study. Based on that, we offer specific research questions for future Green IS study. Finally, we conclude by summarizing the findings and discussing implications for research and practice.

2 Background of Green IS

2.1 Green IT and Green IS

To be consistent with previous research, we choose to adopt Green IS to understand how IS support sustainability (Watson et al., 2010). Previous studies have found that sustainability is a complex phenomenon and it is necessary to go beyond just

environmentally friendly computing. However, given that Green IT is widely used in practitioner literature, it is useful to clarify the similarities and differences between these two terms.

The difference between Green IS and Green IT can trace back to the difference between IT and IS. According to the *Merriam-Webster Dictionary* (online version), IT refers to "the technology involving the development, maintenance, and use of computer systems, software, and networks for the processing and distribution of data". Therefore, it emphasizes the technical infrastructure. On the other hand, IS is defined as "an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals" (Watson et al., 2010, p. 24). Therefore, the IS discipline proposed Green IS to include a variety of possible initiatives to support sustainable business process, and argues that the concept of Green IT may lead us to emphasize the technology too much and result in a limited focus (Watson et al.). As such, Green IT can be seen as part of Green IS.

Given this distinction, we see that the previous example of IBM mainly focuses on Green IT. If IBM extends its project and considers broader areas of issues such as manufacturing process redesign, product innovation, and social practices of IT use, then the project will become a good example of Green IS.

In conclusion, our definition of Green IS goes beyond Murugesan's (2008) definition of Green IT. Our definition encompasses the technology, the human aspect, and the organizational mindset and culture concerning Green IS as well. As IS researchers, we define Green IS in two ways: as 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. In the following sections, we use Green IS unless we refer to practitioner literature or when original publications use Green IT.

2.2 Eco-Goals of Green IS Initiatives

Next, we present the potential eco-goals of Green IS initiatives. The eco-goals are quite relevant because the Green IS initiatives that companies choose to conduct heavily depend on the goal they want to achieve. For example, if companies simply plan to reduce energy consumption, they may just focus on data centers. Otherwise, when companies want to create a better image, they may develop new policies on procurement, operations, and/or disposal of computing equipment (Murugesan, 2008). We identify and propose several eco-goals which are relevant to Green IS initiatives: eco-capacity, eco-efficiency, eco-effectiveness and eco-collaboration (Dyllick & Hockerts, 2002).

Eco-capacity is to make profits within the carrying capacity of the earth (DeSimone & Popoff, 1997). It includes three essential "system rules" that human activities need to respect: (1) substances from the crust must not increase systematically; (2) substances produced by society must not increase systematically; (3) the

physical base for the production and diversity of nature must not diminish systematically (DeSimone & Popoff). Eco-capacity offers valuable insights that some limits exist and the targets are moving ones. However, it is difficult, if not impossible for companies to identify the precise relationship between their activities and the earth's carrying capability.

Treating eco-capacity as the bottom line, eco-efficiency is defined as "the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing environmental impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity" (DeSimone & Popoff, 1997, p. 47). Eco-efficiency is relevant for Green IS because eco-efficiency captures the notion of reducing inputs (e.g., energy) per unit of output (Gray & Bebbington, 2000). The simplest example would be data center redesign so that the data center would consume less energy while maintaining the same or achieve better performance. Therefore, eco-efficiency is in line with the goals of companies, as companies are continuing to try to achieve their activities with lower cost. Thus, we see eco-efficiency an important eco-goal that a company can pursue with Green IS initiatives.

The concept of eco-efficiency is not without limitation. As McDonough and Braungart (1998) argued, eco-efficiency essentially means "doing more with less" (p. 82). However, as the output of organizations rises, their overall environmental impact continues to rise. For example, the environmental impact of industrialization continues to rise despite significant improvements in eco-efficiency. Therefore, McDonough and Braungart proposed eco-effectiveness which involves the design of product that "celebrate interdependence with other living systems" and "work within cradle-to-cradle life cycles rather than cradle-to-grave ones" (p. 88). As they explained later, eco-effectiveness refers to working on the right things instead of making the wrong things less bad (McDonough & Braungart, 2002). Eco-effectiveness is also relevant to Green IS initiatives and complementary to eco-efficiency. While eco-efficiency might focus on reducing the energy consumption of computing equipment, eco-effectiveness may guide companies to design computing equipment with more environmental friendly or even natural materials.

Nowadays, companies increasingly integrate their business processes with each other, and they realize that Green IS initiatives cannot and should not be limited within companies. For example, Michael Dell suggested holding supply chain partners to the same green computing parameters (Beach, 2008). Therefore, Green IS initiatives may not stand alone and need the collaboration between companies, partners, and even customers. In these contexts, the benefit of Green IS initiatives goes beyond the scope of a single company. Therefore, we propose eco-collaboration and define it as collaboration between companies and other stakeholders, such as partners and customers, to maximize the benefit of eco-efficiency and/or eco-effectiveness through product and/or business process redesign. By collaborating with other stakeholders, companies may achieve more efficient business processes besides lower total cost. For example, a company may collaborate with its customers to design to more environmentally friendly products, or collaborate with its partners to redesign their supply chain management systems so that less energy is required.

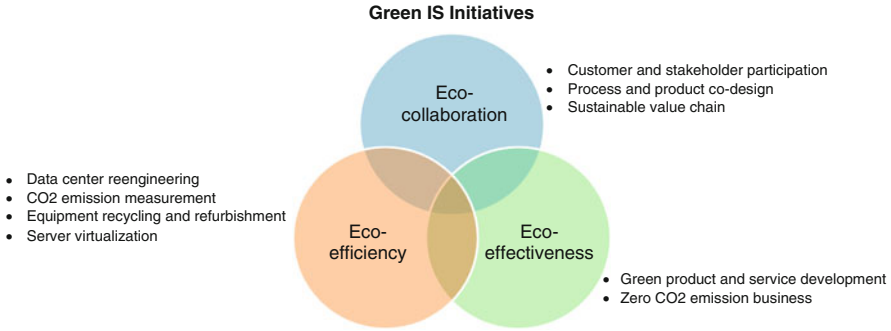

Fig. 1 Three-sided diagram of eco-goals of Green IS initiatives

To summarize, we present our three main eco-goals in Fig. 1. As discussed above, eco-capacity is the bottom line of eco-efficiency. Therefore, we do not include it in our figure. Depending on their specific goals, companies may choose various Green IS initiatives. Examples in Fig. 1 are from practitioner literature (Siggins & Murphy, 2009). Note that the three goals are complementary rather than exclusive, and companies may follow more than one goal at the same time. For example, companies may redesign their data center together with their partners. In this case, their eco-goals include both eco-efficiency and eco-collaboration.

3 Literature Review

3.1 Method

In order to get a sense of the current state of Green IT/IS studies, we examined both practitioner and academic literature.

For the practitioner literature, we reviewed multiple practitioner publications, including *Communications of the ACM*, *CIO*, *PC World,* and *IT Professional*. Additional articles that are relevant and useful for our study are also included in this chapter. For the purposes of our review, obvious advertisements and editorials were eliminated from our analysis.

In terms of the academic literature, our review began with a search of six premier academic IS journals: *MIS Quarterly*, *Information Systems Research*, *Journal of MIS*, *Journal of the AIS*, *European Journal of Information Systems*, *and Information Systems Journal*.[1] However, we only found two "issues and opinions" papers related to Green IS in *MIS Quarterly*. We then expanded our search by including

[1] At the time of the review, these six journals are proposed to be top journals by seniors scholars: http://ais.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=346.

other journals and conference proceedings. Specifically, we searched *MIS Quarterly Executive*, *AMCIS* (Americas Conference on Information Systems), *ICIS* (International Conference on Information Systems), and *PACIS* (Pacific Asia Conference on Information Systems). Additional studies from other conferences or sources were included if they were determined to be relevant and useful for our study. We excluded two "issues and opinions" papers from *MIS Quarterly* in our review given that these two papers do not examine any specific topic of Green IS. In other words, although we found two articles in *MIS Quarterly*, they are not relevant articles for our review.

We found that the first time the term "Green IT" appeared was 2007 in *CIO Magazine*; as such, we considered 2007 as the beginning date for our search; as such, the search covered the years 2007–2010. We used the terms "green", "sustainability" and "environment" to identify relevant articles by searching their abstract and key words. We conducted our search by going through each outlet mentioned above. Given that "Green IT" or "Green IS" is still new and there are relatively few publications, we also searched Google to identify relevant practitioner publications and Google Scholar to identify useful academic publications.

3.2 Practitioner Literature Review

Based on the review from the published practitioner literature, we identified four classes of articles: benefit, initiation, phases for adopting Green IT, and Green IT approaches and strategies. The publications that we identified are shown in Table 1. Specifically, to come up with the classification, we did not focus on the technical aspects of the articles. Instead, we paid more attention to the issues that each article discussed or tried to address. For example, one article may discuss data warehouses while another deals with cloud computing. As long as they both focus on the benefits of Green IT, we put them into the same category, "benefits". Given that IT advances at a dramatic speed, we believe this approach can help us develop a more stable and useful classification schema. After articles were identified, we conducted a preliminary coding to classify each article. Articles which focused on energy efficiency, cost savings, or profit, for example, are classified into the category of "benefit". For other articles dealing with topics such as adopting, launching, and supporting Green IT, we put them under the category of "initiation". When articles discussed different approaches to treat and manage Green IT initiatives, they are more suitable for the category of "approaches & strategies." Finally, articles were classified into the category of "phases for adoption" when they focused on the processes of adoption and implementation.

In our review of practitioner literature, we searched for "Green IT" instead of "Green IS" since "Green IT" is more popular with practitioners. We would like to note that our search resulted in no articles on Green IS, but many that discussed Green IT. Based on our review, we argue that the main reason for this popularity is that practitioners mainly focus on energy efficiency, such as designing energy efficient hardware, and reducing the energy consumption of data centers (Boudreau

Table 1 Summaries of practitioner literature

Journal/ conference	Reference	Topic/research question	Category	Conclusion
CACM	(CACM Staff, 2007b)	Greener pastures	Initiation	Environmental pressures may force organizations to find greener way of doing the business
CACM	(CACM Staff, 2007a)	Mainframe power usage monitor	Initiation	IBM will report power consumption on servers
CACM	(CACM Staff, 2010)	Bell labs and networks' energy usage	Benefit	Bell Labs launched Green Touch to make networks 1,000 times more energy efficient
CACM	(Kurp, 2008)	News about green computing	Initiation	Green computing movement mainly focuses on data centers
CIO	(Beach, 2008)	Talk with Michael Dell about Green strategy	Benefit; initiation	Make green a strategic pillar of the firm
CIO	(Brandon, 2010)	Fuel cells and data center	Benefit; initiation	Fuel cells are highly environmentally friendly, but can also be costly
CIO	(Burnham, 2008)	Green IT budgets getting cut	Initiation	Economic crashes are bad for Green IT
CIO	(CIO Staff, 2008b)	Green initiatives decision	Initiation	Many IT executives still lag in buying energy-efficient products
CIO	(CIO Staff, 2008a)	Intel designed green-certified buildings	Benefits	The building should save about $235,000 annually
CIO	(CIO Staff, 2010)	Sustainability initiatives from CIOs	Benefit; approaches and strategies	Green IT initiatives can improve companies' performance in various ways
CIO	(Nash, 2010)	Sustainability requirements	Approaches and strategies	Businesses require IT vendors to prove sustainability claims
CIO	(Kirk, 2008)	Green IT initiatives in Microsoft	Initiation	Microsoft will launch best practices for running data centers
CIO	(Overby, 2007)	Introduction of new technology into data center	Benefit	VistaPrint expects to save nearly $500,000 and cut carbon emissions by several hundred tons
CIO	(Ricknäs, 2009)	Greener profits	Benefit	European companies net 2% profits
CIO	(Rosenbaum, 2007)	Editorial note	General	Comments on green practices and sustainability in April 1, 2007 issue

(continued)

Table 1 (continued)

Journal/ conference	Reference	Topic/research question	Category	Conclusion
CIO	(Sacco, 2008)	Green ranking	Initiation	Sony Ericsson ranks the first
CIO	(Shah, 2008)	Vendors and legislative mandate for recycling	Approaches and strategies	Vendors begin to push through a legislative mandate for recycling
CIO	(Swanborg, 2009)	Raytheon' Green IT strategy	Benefit	Raytheon project showed benefits for company and environment
CIO	(Varon, 2007)	Benefit of Green IT initiatives	Benefit	Businesses can benefit from Green IT initiatives in various ways
CIO	(Varon, 2008)	Green IT and businesses	Initiation; approaches and strategies	Organizations begin to adopt Green IT initiatives
CIO	(Varon, 2010a)	Green product strategies	Approaches and strategies	IT helps support green product strategies
CIO	(Varon, 2010b)	Sustainability and CIO	Approaches and strategies	CIOs are involved in Green IT initiatives
CIO	(Varon, 2010c)	Systems to support sustainable decisions	Benefit; approaches and strategies	Systems are needed to report energy usage so companies can make better decisions
CIO	(Varon, 2010d)	Green metrics	Benefit	Green metrics helps companies more sustainable
CIO	(Walsh, 2007)	Corporate sustainability initiatives	Initiation; approaches and strategies	IT plays a key role in supporting sustainability initiatives
CIO	(West, 2007)	Data center management	Approaches and strategies	Good practices for managing data center costs
PC World	(Brandrick, 2010)	Green PCs	Approaches and strategies	Different ways to green PCs
PC World	(Perenson, 2009)	Reduced power consumption in internal hard drives	Benefit	Saving money and saving power
PC World	(Rebbapragada, 2007)	Tips on a "green" office	Approaches and strategies	How to save energy and money by good "green" practices
IT Professional	(Murugesan, 2008)	How to take advantage of Green IT	Benefit; initiation; approaches and strategies	Benefit, holistic approach to green IT, how to use IT, enterprise Green IT strategy
Online	(Mines, Brown, & Lee, 2007)	Strategies of Green IT supplier	Phases for adoption	Phases of Green IT initiation

et al., 2007). Therefore, practitioners pay more attention to eco-efficiency and relatively ignore eco-effectiveness and eco-collaboration; they focus more on Green IT instead of Green IS.

3.2.1 Benefits

Given that Green IT was recently proposed by practitioners, most articles we identified aimed to inform managers that Green IT initiatives were not simply a liability and companies could benefit from adopting Green IT initiatives. For example, Kurp (2008) exemplified how Green IT initiatives could reduce data centers' energy consumption. In another example, IBM launched a program to monitor energy consumption and demonstrate cost savings (CACM Staff, 2007a). Overby (2007) reported that VistaPrint received significant savings and cut carbon emissions with Green IT initiatives. In a talk about energy efficiency, Michael Dell discussed that Dell was committed to reducing energy consumed by data centers (Beach, 2008). With Green IT initiatives, Raytheon realized more than $11 million of savings in 2008 (Swanborg, 2009). In Europe, companies which conducted Green IT initiatives were found to earn 2% higher profit margin than others in the same industry (Ricknäs, 2009). Lastly, some studies tried to show specific technology in Green IT initiatives. For example, Perenson (2009) discussed a power-saving green hard drive.

The importance of Green IT is becoming slowly recognized in the practitioner literature. Mingay (2007), in a Gartner presentation at the World Economic Forum in Davos, Switzerland, called Green IT a "new industry shock wave." As Pollack (2008, p. 1) pointed out in a report on green and sustainable IT oriented to education, "seldom does a day pass in which we don't hear or read about sustainability or 'going green'."

However, although many organizations have a heightened awareness level regarding Green IT, they may not be completely committed to Green IT beyond simple energy savings. According to GreenerComputing.com (2008), energy efficiency was being used in one way or another to reduce environmental impacts and to cut costs by at least 65% of IT managers. In a survey by Sun Microsystems Australia, reducing power consumption and lowering costs were the major reasons for adopting Green IT initiatives (Murugesan, 2008). We argue that the narrow focus of the benefits of Green IT initiatives may limit the potential of Green IT and prevent companies from thinking of Green IT initiatives from a strategic perspective.

3.2.2 Initiation

Many publications discussed factors which may influence the implementation of Green IT initiatives. For example, Michael Dell mentioned that cost savings was the primary driver, and shareholder or regulatory pressures might also influence initiation of Green IT (Beach, 2008). In another report, the economic environment was found to

be an important factor to influence Green IT initiation (Burnham, 2008). Specifically, when an economic crash occurs, CIOs might reduce or cut the budgets for Green IT initiatives.

3.2.3 Phases for Adopting Green IT

Two articles we identified discussed phases for adopting Green IT. For example, Mines et al. (2007) discussed Green IT services engagements and data warehouse solutions in three phases: assessment, planning, and implementation. In the first step, assessment helps organizations understand their current situation and create a baseline of potential Green IT initiatives. Typical activities involve creation of an overall Green IT plan and modeling the return on investment. In the planning step, organizations develop the roadmaps for specific Green IT initiatives and choose Green IT initiatives that are most important for them based on plans developed in the first step. In the implementation step, organizations specify, purchase, and install appropriate IT to implement a specific Green IT initiative. Depending on the scope of the project, organizations may simply implement a new IT, or introduce new process, policies, and/or practices. These steps are similar to other types of IT projects since Green IT are a specific type of IT. To summarize, adopting Green IT initiatives is a complex process and requires careful planning to choose the specific technologies to implement.

3.2.4 Green IT Approaches and Strategies

With respect to Green IT approaches, some articles provided suggestions as to how to achieve benefit from Green IS initiatives. For example, West (2007) provided six suggestions on how to better manage data centers and lower costs. By focusing on computing equipment, Rebbapragada (2007) offers several suggestions on how to reduce costs with Green IT initiatives.

On the other hand, Murugesan (2008) present a holistic approach to Green IT. Specially, the approach categorizes the phenomenon of Green IT into four complementary paths: green use; green disposal; green design; and green manufacturing. These categories encompass areas of emphasis and activities such as:

- Designs and strategies for environmental sustainability including data center design and location (Cameron, 2009; CIO Staff, 2008a)
- Energy-efficient computing including power management and virtualization (Cloud computing and SaaS) (CACM Staff, 2007a)
- Disposal and recycling practices that are responsible, sustainable, and comply with applicable regulatory requirements along with pollution prevention (Murugesan, 2008)
- Green metrics, assessment tools, and a methodology (ISO 14001) for effective use and practice

Murugesan (2008) also argues that enterprise Green IT strategies that a company could follow include a tactical incremental approach, a strategic approach, and a deep green approach. The above discussion emphasizes that Green IT initiatives can go beyond energy consumption reduction and cost savings.

To summarize, although practitioners have started to pay attention to Green IT, they mainly focus on eco-efficiency, given that the benefits they identified from Green IT mainly come from energy efficiency and cost savings. One exception is Murugesan (2008); the four paths identified in the article cover the three eco-goals. Specially, green use and green disposal relate to eco-efficiency, green design and green manufacturing relate to eco-effectiveness, and green disposal, green design, and green manufacturing potentially relate to eco-collaboration. Given that Green IT is a complex and multi-dimensional phenomenon, we suggest that practitioners pay more attention to the other two eco-goals so that they can identify greater potentials and benefits from Green IT.

3.3 Academic Literature

By reviewing the academic literature, we identify four classes of Green IS studies: benefits, initiation, frameworks for adopting Green IS, and enterprise Green IS strategies and practices. The articles that we identified are shown in Table 2. For example, we found one published article from *MIS Quarterly Executive* dealing with Strategies & Practices. A similar approach was used for classifying the academic literature. One difference is that in the academic literature, we have the category of "frameworks for adopting Green IS" instead of "phases for adoption". This category includes articles focusing on topics such as the development lifecycle followed and the implementation frameworks used. The reason is because the academic literature is more theory-driven and the term "framework" is more suitable here.

3.3.1 Benefits

There are two major categories of benefits: environmental benefits and cost reduction benefits.

For environmental benefits, Jørgensen and Jørgensen (2009) examine the potential environmental risks related to IT together with nanotechnology and biotechnology, and recommend future studies on the relationship between technology and society, implying that IT needs to be environmentally green. Realizing that IT is just a part of IS, Green IS initiatives, on the whole, hope to transform organizations, such that business practices become more sustainable.

Cost reduction is a major benefit of Green IS initiatives. For example, Hopper and Rice (2008) showed how system-level optimizations of power consumption could be achieved, which in turn lowered the operating costs. In another study,

Table 2 Summaries from academic literature

Journal/conference	Reference	Topic/research question	Category	Conclusion
ACIS 2009	(Molla et al., 2008)	Green IT readiness framework	Initiation	Attitude, policy, practice, technology and governance are the five drivers
PACIS 2008	(Huang, 2008)	System development lifecycle	Adoption framework	SSDLC is proposed that put emphasis on sustainability
PACIS 2009	(Sarkar & Young, 2009)	Managerial attitude of Green IT	Initiation	Attitudes are transformed into action when a sound model exists, with designed long-term awareness programs
PACIS 2009	(Vykoukal, Wolf, & Beck, 2009)	Relationship between Green IT and Grid technology	Benefit	Green IT has economical and ecological benefits; increases the companies' competitiveness
PACIS 2009	(Molla, 2009)	Organizational motivation for Green IT	Enterprise strategies and practices	A Green IT-reach-richness matrix to classify Green IT strategies and initiatives
PACIS 2010	(Ijab, Molla, Kassahun, & Teoh, 2010)	Spirit, practice and impact of Green IS	Adoption framework	Green IS lifecycle framework is proposed
PACIS 2010	(Lee & Caselegno, 2010)	Business models for sustainability	Green IS initiatives characteristics	Key dimensions are suggested to design new business models for sustainability
AMCIS 2009	(Mann, Grant, & Singh Mann, 2009)	The implementation framework of Green IT	Adoption framework	Three step implementation framework for Green IT
AMCIS 2009	(Sayeed & Gill, 2009)	Explore the implementation of Green IT measures	Enterprise strategies and practices	Organizations can leverage Green IT implementation for strategic purposes by mobilizing dynamic resources
AMCIS 2010	(Iacobelli, Olson, & Merhout, 2010)	Green IT/IS review	General	N/A
AMCIS 2010	(Kim & Ko, 2010)	Identify Green IT leaders	Green IT leaders	Several key variables can reasonably identify Green IT leaders
AMCIS 2010	(Kuo & Dick, 2010)	Exploring the factors influencing the extent of green IT	Initiation	The extent of green IT is influenced by management, bottom line considerations and normative legitimation pressures
AMCIS 2010	(McLaren, Manatsa, & Babin, 2010)	Classification schema for Green IT initiatives	General	A new classification scheme for Green IT initiatives
AMCIS 2010	(van Osch & Avital, 2010)	Sustainable innovation	Benefit	Illustrate how sustainable innovation has a greater potential for change and innovation

AMCIS 2010	(Schmidt, Erek, Kolbe, & Zarnekow, 2010)	Predicators of Green IT adoption	Initiation	Importance and uncertainty are main determinants
ICIS 2009	(Chen, Watson, Boudreau, & Karahanna, 2009)	Institutional pressures and the adoption of Green IS&IT	Initiation	Mimetic and coercive pressures significantly drive Green IS&IT adoption
ICIS 2009	(Hedwig, Malkowski, & Neumann, 2009)	A approach to Taming energy costs of larger enterprise systems	Other (model design)	The prediction of future workload allows about 25% saving of total energy cost
ICIS 2009	(Molla, Cooper, & Pittayachawan, 2009)	Validate Green IT readiness model	Initiation	G-readiness construct and model
ICIS 2010	(Mithas, Khuntia, & Roy, 2010)	Adoption and efficacy of Green IT initiatives	Benefit; initiation	Top management commitment takes an important role; implementation is positively related with energy saving and profit impact
ICIS 2010	(Corbett, 2010)	Literature review	General	Review current literature and develop theoretical propositions
International Journal of e-Business Management	(Molla, Pittayachawan, Corbitt, & Deng, 2009)	An comparison of Green IT diffusion	Initiation	The disposal of IT in an environmentally friendly manner is the most relevant concern about Green IT
MIS Quarterly Executive	(Weiss, 2009)	UPS experience with Green IT	Enterprise strategies and practices	Collaboration between IT and other business units at UPS to implement sustainable initiatives

Vykoukal et al. (2009) argued that Green IT initiatives (Grid technology) had economical benefits for companies.

Thus, the benefits identified from the academic literature are consistent with those from the practitioner literature. However, as discussed above, there are different eco-goals for Green IS initiatives, which result in different benefits. Simply focusing on cost reduction may limit our understanding of Green IS initiatives and prevent us from harvesting other benefits such as better business processes or a more positive company image.

3.3.2 When and Why to Initiate Green IS

Molla et al. (2008) evaluated the readiness of organizations' adoptions of Green IT initiatives. They found five important factors of success in Green IT—attitude, policy, practice, technology, and governance—which together determined if the organization was ready to adopt Green IT initiatives. The combination of these five factors was unique to each organization, and enabled the organization to deploy environmentally sustainable IT and IT processes. Later, Molla (2009) developed a matrix to classify motivation in the adoption of Green IT initiatives, and Molla et al. (2009) examined the status of the diffusion of Green IT initiatives as well as factors that influenced it. In another study, Sarkar and Young (2009) found that the existence of an effective cost model and awareness programs surrounding Green IT initiatives would influence managerial attitudes towards Green IT. More recently, Kim and Ko (2010) used financial and environmental indicators to identify Green IT leaders versus followers. Further, Kuo and Dick (2010) examined how factors such as the influence of management, bottom line considerations, and normative legitimation pressures influenced the extent of Green IT adoption in organizations. Similarly, Schmidt et al. (2010) examined the predictors of Green IT adoption. All these studies offer a good starting point in terms of understanding the initiation of Green IS, though the articles mentioned only focus on IT instead of IS.

3.3.3 Framework for Adopting Green IS Initiatives

Mann et al. (2009) developed a three step implementation framework for Green IT initiatives: determination of the external and internal factors, determination of the sophistication of the strategy, technology, and processes, and measurement of the sustainability of the proposed venture. This framework is similar to the three phases proposed by Mines et al. (2007). More recently, Van Osch and Avital (2010) argue that the sustainable innovation was an extension of the current Green IT/IS frameworks and illustrate how a company could go from Green IT to Green IS to sustainable innovation.

3.3.4 Enterprise Green IS Strategies and Practices

IS researchers seem more interested in the potential of Green IS initiatives from a strategic perspective. For example Vykoukal et al. (2009) argued that Green IT could increase the companies' competitiveness. In another study, Sayeed and Gill (2009) showed that by mobilizing their dynamic resources while implementing Green IT initiatives, organizations were able to take advantage of Green IT for strategic purposes. More recently, Iacobelli et al. (2010) showed five examples of implementation from current leaders in Green IT/IS and how these leaders benefited from Green IT/IS initiatives. Also, McLaren et al. (2010) proposed a classification scheme for Green IT initiatives. Although not directly related to Green IT, Weiss (2009) talked about how to use IT to reduce miles of travel and improve vehicle parts replacement "through a structured approach of gathering data, analyzing that data, and simplifying jobs" (p. 101). Consistent with Molla (2009), Green IS initiatives can not only measure the energy being used but also reduce it. These studies tried to understand Green IS initiatives beyond eco-efficiency and should have great potential in further studies.

To summarize, the IS discipline began to pay more attention to the Green IS phenomenon from 2008. Though many of the articles discuss Green IT, as it is an aspect of Green IS, this research is still useful for understanding the whole. Similar to practitioners, academic researchers also feel that it is quite important to illustrate the benefits of Green IS initiatives and understand and what influences the initiation of Green IS initiatives. Referring back to the three eco-goals discussed previously, these two classes of research also mainly focus on eco-efficiency. Another exciting trend is that researchers are slowly beginning to realize the potential of Green IS initiatives for companies from a strategic perspective, and are trying to understand Green IS initiatives beyond the more direct benefits such as energy efficiency. On the other hand, determining how to ensure the success of implementing Green IS initiatives seems to have received relatively little attention.

4 Assessment of the Current State of Green IS Research

After reviewing the articles from the practitioner and academic literatures, there does not appear to be a large gap between them (refer to Fig. 2). First of all, both communities pay much attention to the benefits of Green IS initiatives. Practitioners especially want to know what this new kind of IT can bring on board for their businesses and how their organizations can potentially benefit from different kinds of Green IS initiatives. Given that Green IS initiatives are relatively new, top managers need to justify why the organization should go with Green IS initiatives. Therefore, the topic of benefits of Green IS initiatives is a major focus from both practitioner as well as academic literature.

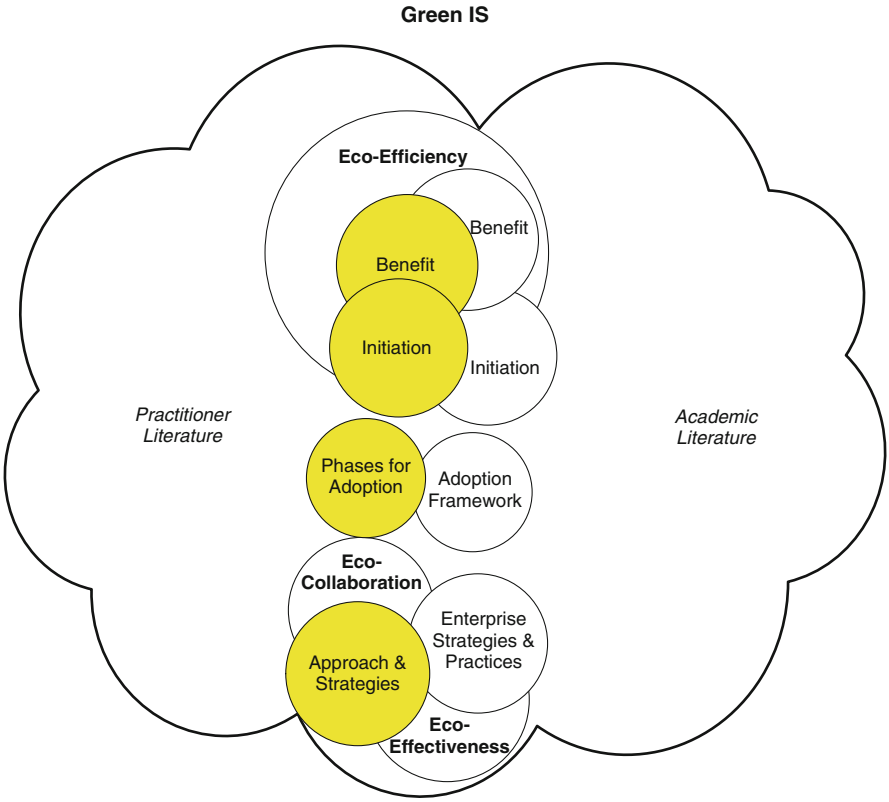

Fig. 2 Focus and overlap in the reviewed literature

Although benefits are one of the main reasons for organizations to adopt Green IS initiatives, it is not the only reason. Other factors, such as government regulation and attitudes toward Green IS initiatives may also play an important role. Therefore, theoretical-based models and approaches are needed to understand the initiation of Green IS initiatives. As such, it is not surprising that initiation is another topic valued by practitioners as well as researchers.

Both communities are also beginning to realize the potential of Green IS initiatives beyond recycling and energy efficiency. Academic literature seems to go a step ahead of practitioner literature and is more excited about other aspects of Green IS initiatives beyond the technical aspect. The studies identified in the class of enterprise strategies and practices certainly go beyond eco-efficiency and touch into eco-effectiveness and eco-collaboration. It once again confirms that Green IS initiatives can be more valuable and beneficial than Green IT initiatives, and that they deserve much attention from the IS discipline.

Lastly, both communities seem to relatively ignore the process of implementing Green IS initiatives. This is understandable, given that Green IS initiatives are still fairly new and there may be relatively little information or few cases on Green IS

initiatives. However, whether or not organizations can harvest the benefits of Green IS initiatives largely depends on the degree to which these initiatives are successfully implemented. From previous IS literature, we know that investing in IT does not necessarily lead to benefits, and organizations often fail to implement IT successfully. Therefore, we believe that this topic is at least as important as other topics, and future studies should pay more attention to it.

Although the gap between the two focal areas of literature is small, the important question to ask is: "Have we as IS researchers done a decent job in terms of studying Green IS?" To date, arguably, we have not. The reasons are as follows:

- The number of papers we identified in our review of the research literature is limited. To be specific, there are only two "issues and opinions" papers, from *MIS Quarterly,* in the six premier IS journals reviewed.
- Limited theories have been developed and applied relating to Green IS.
- Few empirical studies of Green IS have been performed.

Academic research in Green IS is still immature; we suggest that the IS research community needs to focus more on this increasingly important topic.

5 Recommendations for Future Green IS Research

In order to further Green IS research, we identify some of the most important topics of interest in Green IS studies. We hope that the topics we identify will be of use to further the research of Green IS.

A point of interest is that we found few studies that explicitly deal with Green IS in academic literature. One exception is an "issues and opinions" paper from *MIS Quarterly*. In their paper, Watson et al. (2010) propose the concept of Green IS and discuss why Green IS is more suitable than Green IT for IS literature. Therefore, our first recommendation is that future studies should focus on Green IS instead of Green IT. Specifically, although the technical aspects of Green IT are certainly important, we as IS researchers should go beyond IT infrastructure and focus on other aspects of Green IS, such as business processes.

Most of the articles from the practitioner literature discuss the benefits of Green IS initiatives. This is mainly due to the fact that Green IS initiatives are relatively new and immature, and managers need to justify Green IS initiatives. For example, West (2007) describes how good Green IS practices can aid in efficiently managing data centers and lower the costs. He admitted that "convincing your enterprise to fund data center improvements not directly related to business delivery can be a challenge" (p. 64). Thus, we can see that the practitioners are eager to understand the role of Green IS and why they need to fund Green IS initiatives.

In the academic literature reviewed, Sarkar and Young (2009), p. 6 identified two gaps in the existing research literature; one of which is "a lack of understanding of senior IT management attitudes concerning environmental policy". In addition, Molla et al. (2008) also argues that attitude was one of five factors which influence

Green IT success and readiness. Attitude toward Green IS adoption, or to phrase it differently, the motivation to be green, is indeed one of the most important issues to understand in studying Green IS. Here, we use motivation as an example to illustrate how we can understand it from theoretical perspectives. Note that we do not intend to limit Green IS adoption research to motivation only; other perspectives and approaches could be equally or potentially even more important.

One of the most prudent research questions for future study concerning organizational motivation to Green IS initiatives is:

What motivates a company to decide to adopt Green IS initiatives?
Following chronologically through a project's life cycle, after firms decide to initiate Green IS, projects will begin. This substantial undertaking has the potential to manifest any number of policies and procedures concerning how to best manage the project. There have been few published studies as of now that describe how the firm should handle this decision. As such, the next research question to address is:

How should the firm manage the process of Green IS adoption?
Finally, it is not a guarantee that adoption of Green IS initiatives will be wholly beneficial for the firm. If the act of undertaking Green IS initiatives guaranteed a positive outcome, there wouldn't be a need to debate the merits of adoption; every company would adopt every Green IS initiative that is feasibly possible. Given that there might be potential negative impacts or consequences to the adoption of the initiative, our final proposed research question is:

What are the impacts of Green IS initiatives?

6 Conclusion

Organizations are increasingly realizing the importance of sustainability, and many are trying to design or redesign their business processes so that their activities are more environmentally friendly (Klassen & Vachon, 2003). Although IS literature has examined how IS can support various business processes and improve the efficiency and effectiveness of organizations, few studies have focused on how Green IS initiatives can improve organizations' performance by enabling new sustainable practices and processes. The Green IS discussion has not made its way into mainstream practitioner literature yet. But we feel that when the academic IS community begins to focus on Green IS, and demonstrate through empirical research how it can help business, the practitioners will follow suit.

Given that there is a lack of direction in terms of the specific topics and approaches to conduct rigorous research on Green IS, in this chapter, we offer specific research directions on Green IS. By reviewing both practitioner and academic literature, we identified the topics that previous literature has covered as well as the similarities and differences between the practitioner and academic focuses. Based on these results, we present three questions which we believe are

relevant and valuable for future Green IS studies. Specifically, the first question deals with pre-adoption motivation, the second question focuses on the process of adoption and the third question examines the impact of adoption. Therefore, these three questions span the whole process of Green IS implementation and should be representative of the entire timeline.

Given the diversity within the academic literature, there can be various topics or approaches to examining Green IS; the research questions we suggest do not aim to be definitive. Rather, our purpose is to illustrate how researchers may start to understand and examine Green IS. We do recognize that there are other valuable questions which can be pursued and help us understand sustainability in general, and Green IS in particular. We hope that our review can further the understanding of Green IS, and that IS researchers pay more attention to this important phenomenon. We believe that we, as scholars, should contribute our knowledge in terms of how to make our planet healthier, and more sustainable, such that there is a benefit for all.

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