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Green IS Research: A Modernity Perspective

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Abstract:

Over the past two decades, the information systems community has become engaged in improving the environmental effects of information systems and technologies, which has given rise to the green IS field. Despite increasing interest, some have suggested that progress toward meaningful solutions for sustainability has been too slow. Responding to these concerns, we examine the development of green IS research using the modernity perspective to understand green IS's evolution and to present alternative perspectives to motivate future research. From a sample of over 80 green IS papers published over a 15-year period, we identify four main patterns of modernity that are manifest in green IS research. These patterns include the importance of the individual in solving environmental problems; science as the main source of solutions; and the emergence of an artificial science approach, reliance on technology, and growth as businesses' ultimate goals. Further, our analysis reveals that green IS research has started to demonstrate elements of a hyper-modernity perspective that emphasizes reflexivity. We argue that future green IS research should continue on this path and propose a conceptual framework inspired by hyper-modernity and centered on reflexivity that could serve as a guide for future research.

Keywords: Green IS, IS History, Modernity, Reflexivity, Environmental Sustainability.

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1 Introduction

In March 2015, concentrations of carbon dioxide (CO_2) in the atmosphere surpassed 400 parts per million for the first time in recorded history, which evidences humanity's continued progress toward an unpredictable and unstable future. Meanwhile, Ghosh (2010), for example, has estimated that the cost of environmental damage due to human activities could reach US$28 trillion by 2050. Thus, from both environmental and financial perspectives, humanity faces an increasing urgency to address the challenge of environmental sustainability (Stern, 2008).

Over the past two decades, the information systems (IS) community has become increasingly engaged in research and practice to improve the direct and indirect environmental effects of information systems and technologies. Numerous IS scholars have called on their colleagues to examine the relationship between IS and environmental sustainability (Brocke, Watson, Dwyer, Elliot, & Melville, 2012; Pernici et al., 2012), which has given rise to the green IS field (Elliot, 2011; Jenkin, Webster, & McShane, 2011a; Melville, 2010b). Broadly speaking, green IS refers to improving the flow and management of information to support more environmentally favorable practices and decisions (Boudreau, Chen, & Huber, 2008). For this paper, green IS subsumes green IT, which refers more specifically to the hardware and other infrastructure that one can better manage and design from an environmental perspective (Sarkis, Koo, & Watson, 2013).

With sufficient history and an important future, one could consider green IS research to be in its adolescence. Although green IS has contributed to improving organizations' environmental impacts (Seidel, Recker, & vom Brocke, 2013; Watson, Boudreau, & Chen, 2010b), some suggest that progress in this area has been too slow (Brocke et al., 2012). In this paper, we retrospectively look at green IS research's development to understand its evolution and to highlight alternative perspectives as a means of motivating future research and more rapid advancement in the area.

Scholars have used several sociological perspectives to explain the development of the sciences, one of which is modernity. Modernity is a philosophical perspective that emerged at the end of the Enlightenment period in the 17th century. The modernity perspective helped to shape societal development, first in Europe and subsequently around the world (Giddens, 2013), by replacing the institutional controls of religion, magical enchantment, and tradition with reasoned empowerment. Modernity itself, however, creates new challenges, which the social sciences must understand and address if they are to move forward (Giddens, 2013). Sim (2010) and York, Rosa and Diets (2003) have identified sustainability as one of these new challenges such that they have begun to consider the relationship between sustainability and modernity. We contend that green IS research, as a leading candidate to deal with contemporary sustainability challenges (Brocke et al., 2012), should also consider modernity's potential influence on green IS's future development and trajectory.

Although modernity has occupied sociological debates, to our knowledge, IS researchers have devoted little attention to exploring this concept. Among the exceptions, we found research capturing some aspects of modernity in relationship with IS, such as using the notion of "risk society" (Beck, 1992a, 1992b) in the context of IT risk management (Jacucci, Grisot, & Hanseth, 2004). Other authors have drawn on the modernity perspective in developing ecological modernization theory and applying it to understand the relationship between technology and the environment (Mol, 2003; Sarkis & Cordeiro, 2012). In this paper, we do not engage in a debate about modernity itself. Rather, we contribute to green IS research by exploring the following research questions:

RQ1: Is the modernity perspective manifest in green IS research to date? If yes, to what extent?

RQ2: What implications does this manifestation have for future green IS research?

Two main reasons exist for trying to understand the relationship between the modernity perspective and green IS research. First, IS represents an important pillar of contemporary life. Indeed, the current era has been referred to as the "information society" (Fuchs, 2008). Accordingly, it is valuable for IS researchers to evaluate not only how IS can change society but also how society has shaped our field. The modernity perspective has contributed to the current sustainability crisis, and green IS research and practice has developed as one of the improvised solutions to the problem. Second, a systemic relationship between past social events and their current consequences exists (Voss, Bauknecht, & Kemp, 2006). Blair and Hitchcock (2004) explain that any change in society is a result of ultimate forces that operate long before the actual change occurs. Thus, taking the time to understand these forces via deeply analyzing them

may help us in solving similar issues in the future. Analyzing green IS research through the lens of modernity allows one to bring new insights to developing this domain to drive more valuable research.

This paper proceeds as follows. In Section 2, we provide background on the modernity perspective. In Section 3, we describe the methodology we used to select and analyze green IS papers that form the basis of our review. In Section 4, we trace the development of green IS research. In Section 5, we present our findings with respect to the patterns of modernity that are manifested in the body of work. In Section 6, we examine how green IS research is evolving beyond modernity to include patterns of hyper-modernity and propose a conceptual framework based on hyper-modernity that could serve as a guide for future research. Finally, in Section 7, we conclude the paper by noting its contributions and limitations.

2 Conceptual Background

2.1 The Modernity Perspective

A wide array of literature describes the nature and characteristics of modern societies. For example, studying social learning in modern societies, Dyke (2009) asserts the continuing impact of the Enlightenment on contemporary social analysis, while Stø, Throne-Holst, Strandbakken, and Vittersø (2008) uses the sociology of consumption to study the role of consumers and consumption in modern societies.

In this paper, we draw on a comprehensive understanding of modern society through the work of Beck (1992b) and Giddens (2013). We were inspired by Déry's (2009) synthesis of previous work on modernity (e.g., Beck, 1992b; Déry, 2009; Giddens, 2013; Lipovetsky, 2004) in which he represents modernity in the form of a tetrahedron with three poles and three surfaces, which allows one to visualize interactions between societal components (see Figure 1). The poles are nature (the environment where people live), the individual (the human being), and culture (the group). The interaction of the three poles gives rise to three different surfaces: political, technological, and economic (Déry, 2009). To give them sense, the cognitive operator is an essential explanatory lens (Déry, 2009). Under a modernity perspective, reason, having replaced religion and tradition that were prevalent in pre-modern perspectives, is the cognitive operator. With modernity, philosophies centered on the individual and reason prospered, which gave rise to changes to the three poles and their interactions as society attempted to construct a "better future" (Beck, 1992b).

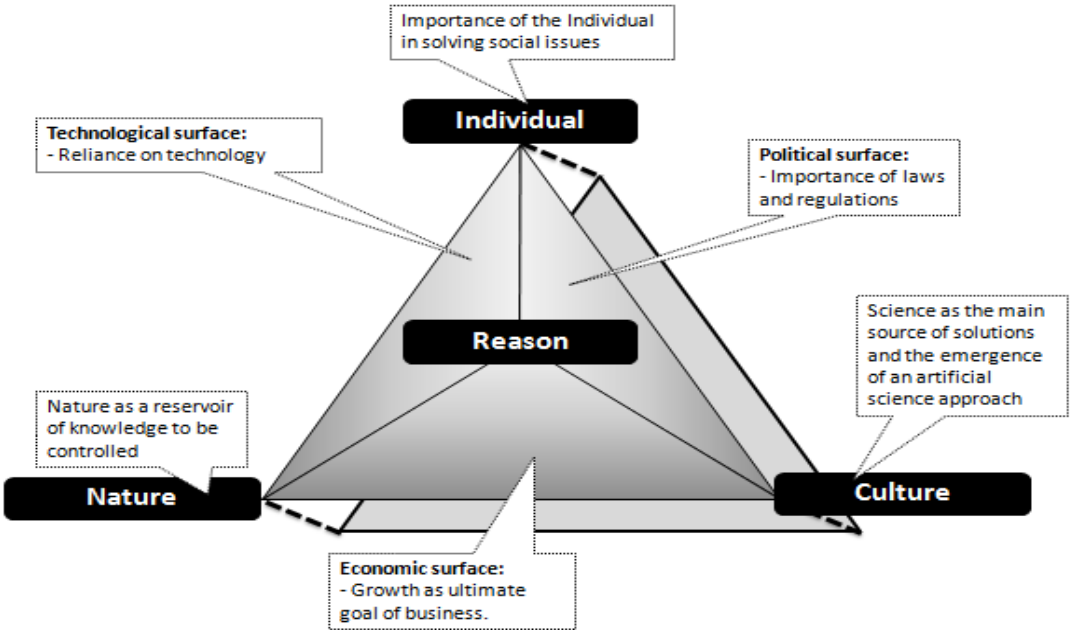

Figure 1. Conceptual Framework of Modernity's Influence on Green IS Research

In Sections 2.1.1 and 2.1.2, we briefly describe poles and surfaces in relation to the modernity perspective.

2.1.1 The Three Poles: Individual, Nature, and Culture

Under the modernity perspective, the individual pole represents the state of an individual who became reasonable and eager for freedom and individual rights (Beck, 1992b). These new rights and freedoms gave the individual the proper environment to build new institutions and domains of science that became individuals' central reference of truth (Lipovetsky, 2004). In addition, this change permitted more individualistic behavior and high self-awareness as the modern individual looked for comfort and prosperity. This general behavior contributed to the emergence of new social phenomena such as the mass consumption of products and services; the emergence of hobbies, especially individual ones; and the desire to satisfy every kind of pleasure (Beck, 1992b). Individuals acquired technological gadgets to have more control over their lives, and information became a tool for acquiring power (Déry, 2009). This created a modern lifestyle with challenging consequences on the other poles and surfaces, specifically nature.

The second pole is nature. In pre-modern times, individuals perceived nature or "Mother Nature" as "holy", and nature was sacred and magical (Beck, 1992b). This relationship impacted human behavior toward nature, which mostly included protecting and respecting it. However, with modernity, nature became an "object" to study, describe, transform according to the needs of the modern Individual (Déry, 2009).

The final pole is culture. Here, the modernity perspective opened the doors to discovery, which allowed science to grow and become the legitimate reference for viable knowledge. At the time of The Enlightenment, "an information revolution and a confidence in the promise of, and deference to, the findings of science" (Dyke, 2009, p. 3) characterized modernity. Some have characterized modernity as a period when "the priests of religion were replaced by the priests of science" (Bauman, 1995, p. 21). Sciences developed in all directions; all things were to be observed, studied, and classified. This scientific exploration eliminated many myths around reproduction, the universe, the sun, and the earth. Besides the natural sciences, artificial sciences and systems, those systems made and operated by humans (Faber, Jorna, & Van Engelen, 2005), such as engineering, architecture, medicine, and management, were established.

2.1.2 Interactions between the Poles: The Political, Technological, and Economic Surfaces

The political surface represents the interaction between the individual and culture poles; in other words, the interaction between individuals and other individuals in society. Under the modernity perspective, the political surface emphasizes advancement empowered via rights and freedoms. People emerged from community parental systems of pre-modernity to form democratic societies (Déry, 2009).

Interactions between the nature and individual poles create the technological surface. According to the modernity perspective, technologies became omnipresent and were used in all domains (Ellul, 1990) . In industry and agriculture, from synthetic fibers to artificial flavors and genetically modified food, individuals applied various technological approaches and techniques to alter and modify nature to achieve their goals (Déry, 2009). Technologies are the core of artificial sciences and the artificial systems that invade all societal domains (Beckman, Nilsson, & Dahlbom, 2002). Through technologies, modern society aims to reach to optimal efficiency to increase growth (Déry, 2009).

As with the other poles and surfaces, modernity brought many changes in the economic surface; that is, the interaction between nature and culture. With modernity, agriculture and industry transitioned from mostly familial, small-scale companies using local capital, raw material, and labor to large, multinational corporations (Blair & Hitchcock, 2004). Many industries grew substantially, stabilized, and became deeply rooted in the economic infrastructures of many societies.

2.2 The Modernity Tetrahedron Applied to Green IS

We used the analytical tetrahedron described above as the basis for our conceptual framework for exploring the development of green IS literature because it allows one to picture the components of society influenced by modernity. In the same manner, it allows one to analyze to what extent these same components are found in green IS research under modernity's influence. As a launching point for our research, from our broad reading of the modernity and sustainability literatures, we identified six key patterns of the modernity perspective that green IS papers could reflect: 1) the importance of the

individual in solving environmental issues[1]; 2) science, specifically the science of green IS, as the main source of solutions supported by the emergence of an artificial science approach; 3) nature as a reservoir of knowledge to be controlled; 4) the importance of laws and regulations to regulate social relationships; 5) reliance on technology in our daily activities; and 6) growth as ultimate goal of business. Figure 1 illustrates how each of these themes relates to the dimensions of the modern society tetrahedron. Table 1 summarizes the themes.

Table 1. Summary of Modernity Patterns

Pole or surface	Pattern of modernity	Description	Manifest in green IS research
Individual	Importance of the individual in solving environmental issues	Modernity considers individuals to have a high self-awareness and free will. New social phenomena such as mass consumption and acquisition of technological gadgets give individuals more control over their lives, and information becomes a means to power.	Yes
Culture	Science as the main source of solutions and the emergence of an artificial science approach	In the culture pole, modernity made science the legitimate reference for viable knowledge. Science is the vehicle for human progress. An artificial science approach emphasizes using expert knowledge.	Yes
Nature	Nature as a reservoir of knowledge to be controlled	Modernity transformed nature into an object to study, describe, and transform according to the needs of the modern Individual.	No
Political	Importance of laws and regulations	The political surface emphasizes enforcing laws to regulate social relationships. All rules in society flow from these laws.	No
Economic	Growth as ultimate goal of business	Modern society is characterized by a developed industrial capitalism with a focus on growth as ultimate goal through rationalizing and mechanizing the economy.	Yes
Technological	Reliance on technology	In modernity, reliance on technology grew in all domains as a means to increase productivity and financial gains.	Yes

One can see that each of these patterns derives from one of the dimensions (poles or surfaces) of the modernity tetrahedron. For instance, the importance of the individual in solving environmental issues relates to the individual pole, while the theme of reliance on technology relates to the technological surface. Although other patterns could be derived from these dimensions, we chose these six because they link directly to the modernity perspective and they represent the prominent characteristic of the pole or surface under consideration. Further, using these six elements as a starting point provides a parsimonious model through which we can make more transparent the patterns of modernity that are present in green IS research.

3 Methodology

To explore the manifestation of the modernity perspective in green IS research, we embarked on a qualitative review of the literature. For this, we followed a scoping approach according to Arksey and O'Malley (2005) that comprised five stages: 1) identifying the detailed research inquiries, 2) identifying relevant studies, 3) refining the papers according to inclusion and exclusion criteria, 4) charting the data, and 5) summarizing and reporting the outcomes.

3.1 Specifying Detailed Research Inquiries

In the first stage, we formulated more precise inquiries derived from our main goal. These inquiries included the following four subquestions (SQ): 1) how has Green IS scholarship evolved over time?, 2)

[1] The social issue in relation to Green IS is the environment.

what have been the qualitative shifts in that knowledge over time?, 3) are elements of modernity present in this research?, and 4) if yes, to what extent does IS research reflect key features of modernity?

3.2 Collecting and Refining the Sample of Papers

In the second stage, we identified relevant papers that would allow us to answer these questions. We started by searching high-quality papers in AIS Electronic Library (AISeL) using several keyword combinations. We chose the terms “environmental sustainability”, “green”, “information systems”, and “modernity”, which could appear anywhere in the text. We did not find papers in this database with all four keywords combined. Thus, we removed the terms “modernity” and “green” and continued with the other key words combined. Our search experience is not unsurprising as coupling “green” with “information systems” is itself relatively new. Brooks, Wang, and Sarker (2012) found that the word “green” was used for the first time in 2007 and Loeser (2013) found that the term “green IS” was used initially in 2008.

We then enlarged the search to ABI/INFORM Global and Trade Business databases using the same keywords to identify green IS papers appearing in other IS and non-IS journals and, thereby, gain a broader perspective. Subsequent to the structured database searches, we collected further papers using a snowball method (as Greenhalgh and Peacock (2005) suggest) in which one finds literature through the literature one has already found. This approach proved to be useful for tracing the specific ideas related to modernity perspective (although not specifically related to green IS). The process worked as follows. First, we found a relevant paper such as Bäckstrand (2004). From the bibliography of Bäckstrand (2004), we identified Hart (1995), who elaborates on a management theory about environmental impact of business. In turn, Hart (1995) drew our attention to Hart (1997). From the Bäckstrand’s (2004) bibliography, we also found references to eco-feminist and eco-modernist movements (Kates, 2002; Raven, 2002), which we investigated and added to our sample as appropriate based on our criteria (see below). We continued this snowball process until we achieved saturation of the key ideas relevant to our inquiries. One reaches saturation when no additional relevant information emerges from the newly read papers (Randolph, 2009). For completeness, we also reviewed the list of green IS papers included in previous literature reviews on the subject (Brooks et al., 2012; Dedrick, 2010; Malhotra, Melville, & Watson, 2013).

We first checked all papers found through our various search techniques for relevance by reading their abstract. We included papers if they presented research focusing on the links between environmental sustainability and information systems (including information and communications technologies), if they were peer-reviewed, and if a full-text version of the paper was available. We also included both empirical and conceptual papers. In the event that we could not determine a paper’s relevance by reading its abstract, we read the entire paper. If we found that the paper had no relationship to our topic, we set it aside; otherwise, we included it. In total, 83 papers satisfied our inclusion criteria.

3.3 Charting the Data

In the third stage, we charted the data. Charting "describes a technique for synthesizing and interpreting qualitative data by sifting, charting and sorting material according to key issues and themes" (Arksey & O'Malley, 2005, p. 27). We charted the data as we collected papers, particularly as we engaged in the snowball method.

To answer SQ1 and SQ2, we extracted key information through a primary analysis of the selected papers. This process translated to collecting descriptive information and categorizing the papers according to these characteristics. Specifically, we extracted the following information from each paper: year of publication, publication outlet, authors and their affiliation, level of analysis, research theme, paper type (empirical or conceptual), and, if empirical, type of research methodology. We discuss the results of this coding in more detail in Section 4.

To answer SQ3 and SQ4, we conducted an inductive approach (Blais & Martineau, 2006). We deeply and carefully read all selected papers and engaged in a preliminary analysis by highlighting and marking the salient ideas related to our predefined elements related to modernity’s influence. During this analysis, we also allowed additional themes to emerge. Finally, we synthesized the themes we identified in the papers and used them to bring greater insights into the research questions we sought to answer. We present the results of these analyses in Section 5.

4 Development of Green IS research

4.1 Profile of Green IS Research

In the past two decades, green IS research has evolved slowly but steadily to become an established IS subfield with major issues to solve. As Figure 2 shows, prior to 2007, only one or two green IS papers appeared annually. At that point, there is evidence of increasing interest in the topic, which peaked from 2010 to 2013. Looking at the data more closely, we note that the volume of publications in these four years is largely due to special issues on green IS. In 2010, *MIS Quarterly* published two papers on green IS as a call to action for IS researchers. In 2011, the *Journal of Strategic Information Systems* published a special issue on green IS, which accounted for nine of the 12 papers published that year. During this period, several other top journals also published special issues on green IS, which helped to augment the number of publications.

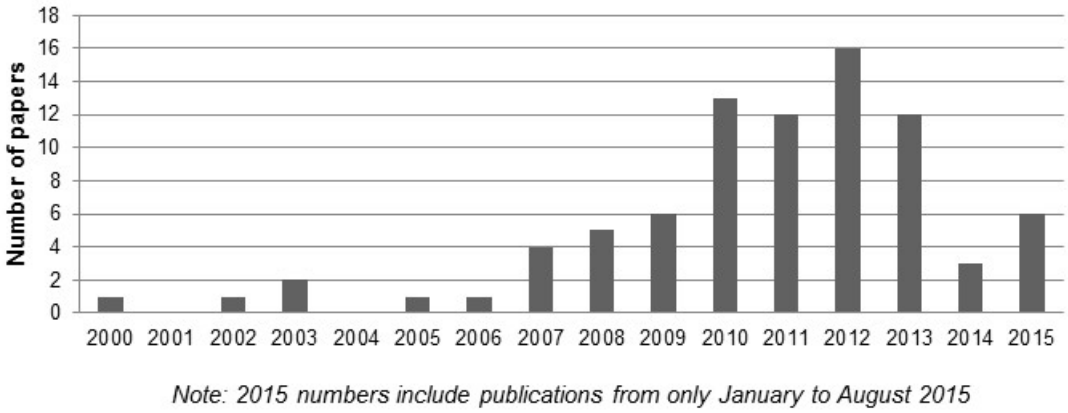

Figure 2. Number of Green IS Papers by Publication Year

To better understand the disciplinary roots associated with green IS research, we examined the publication outlets. In this regard, we found a large number of journals publishing papers on green IS; specifically, 46 different journals in a variety of disciplines published green IS papers. However, among these publication outlets, those related to information systems, computer science, and engineering tended to dominate publications in other domains. Table 2 lists the top ten publications. At the top of this list is the *Journal of Strategic Information Systems* with 10 papers followed by *Energy Policy* and the *Journal of Industrial Ecology* with seven each.

Table 2. Papers by Publication Outlet (Top Ten Journals)

Publication	Number of papers
Journal of Strategic Information Systems	10
Energy Policy	7
Journal of Industrial Ecology	7
MIS Quarterly	5
Information Systems Frontiers	4
Communication of the Association for Information Systems	3
Environment, Development and Sustainability	3
Journal of Computer Information Systems	3
Business and Society	2
Communications of the ACM	2

Another important dimension to consider in the profile of green IS research is the extent of geographic diversity. To determine green IS's geographic diversity, we examined the papers' authorship. In total, we found 185 unique authors. We used the location of the authors' affiliations (207 in total) to further categorize the papers. Table 3 shows the top ten countries. As the table shows, authors from universities based in the United States were dominant: they made up 24 percent of the total. Other countries with active green IS research included Australia, China, and the United Kingdom.

As previous authors have highlighted (Jenkin, Webster, & McShane, 2011b), green IS research is relevant at several levels of analysis. However, we found that the majority of papers (71%) have taken an organizational view of green IS (see Figure 3).

Finally, we investigated each paper's type. As Figure 4 shows, the first empirical paper in our sample was published in 2008. During the early years of green IS research, non-empirical papers, including essays, theoretical pieces, and tutorials, dominated. Such a result is not surprising because the field was just beginning to capture the attention of IS scholars (Brooks et al., 2012). While non-empirical papers contribute to building key concepts and theories, empirical work is required to test theories and validate conceptual knowledge (Chen & Hirschheim, 2004). Thus, one can expect empirical work to become more important as a field or subfield develops. From 2009 to 2013, the split between empirical and non-empirical papers was more balanced, which suggests an increasing level of maturity in the field. In total, for 2000 to 2015, non-empirical papers accounted for 55 percent of green IS publications and empirical papers accounted for 44 percent.

Table 3. Top Ten Author Affiliations by Country

	Total	Percentage of total
United States	50	24%
Australia	22	11%
China	22	11%
United Kingdom	20	10%
Canada	10	5%
Netherlands	10	5%
Taiwan	10	5%
Spain	8	4%
Germany	7	3%
Sweden	7	3%

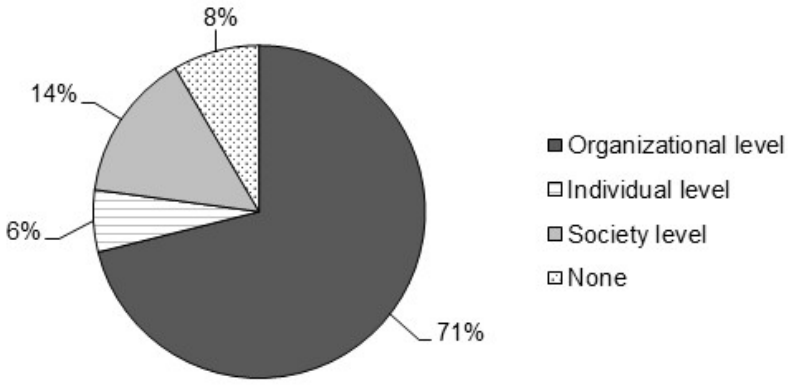

Figure 3. Level of Analysis in Green IS Research

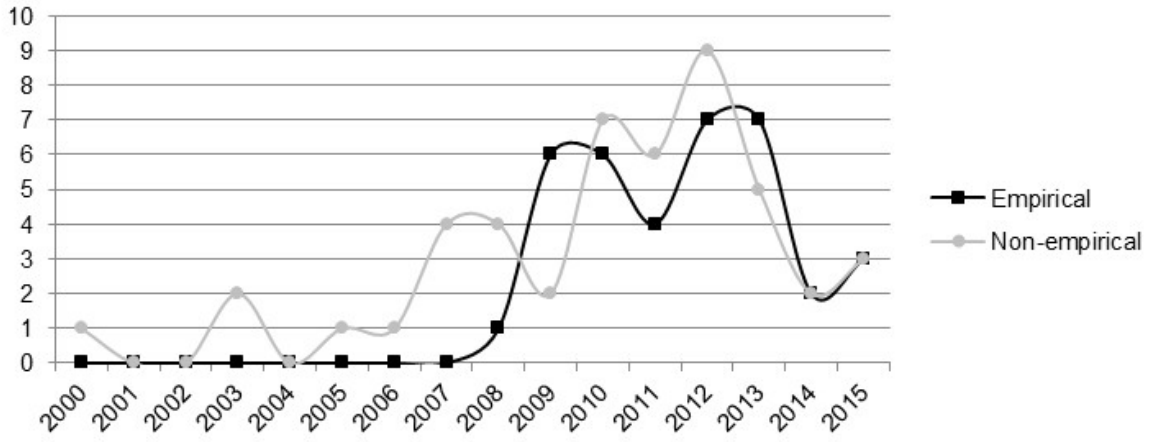

Figure 4. Number of Empirical and Non-empirical Papers per Publication Year

Drilling further into the empirical studies, two main research methodologies dominated: qualitative case studies (representing 35%) and surveys (representing 32%). Figure 5 shows the breakdown between the major research methods used in green IS research.

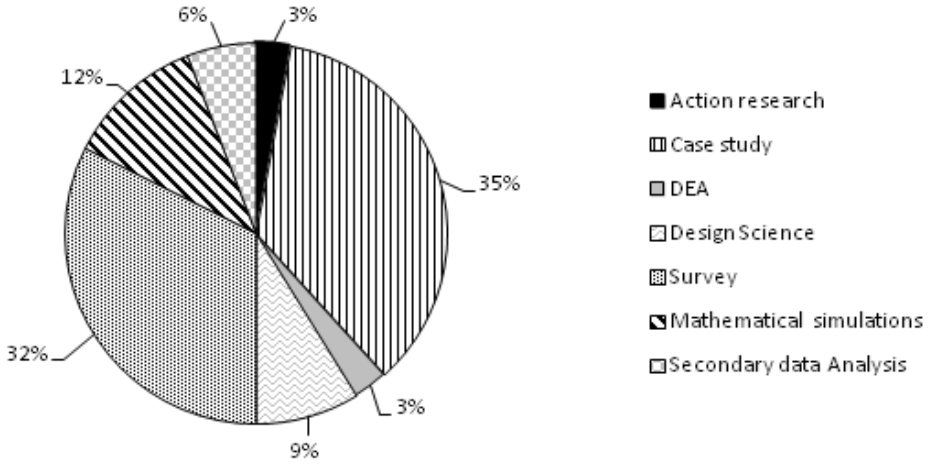

Figure 5. Percentage of Green IS Research Methods

From the above analysis, we note that green IS research has a fair amount of diversity when we consider researchers' geographic profile; the interest in this topic seems to be truly global in nature. However, there is less diversity in terms of the methodological approaches, level of analysis, and disciplinary roots. This profile may help to explain in part why certain themes are more dominant in extant literature, which we discuss in Section 4.2.

4.2 Major Themes of Green IS Research

Moving to more qualitative dimensions of green IS research, our review suggests that, epistemologically, green IS research tends to be more aligned with a transformation paradigm rather than an understanding paradigm. A transformation paradigm implies green IS research is focused on identifying solutions to important problems rather than pursuing purely disciplinary explanations (David, 1999). One can see evidence of this transformation paradigm in the various calls to action related to green IS (e.g., vom Brocke, Watson, Dwyer, Elliot, & Melville, 2013; Watson, Corbett, Boudreau, & Webster, 2012). This finding highlights one of the main influences of modernity on green IS research: the transformation paradigm follows the same logic of artificial science approach, which is itself a result of modernity. Prior to further discussing the patterns of modernity that we can observe in green IS literature, we qualitatively trace the major themes of research in this domain and how they have contributed to the field's development.

Our analysis revealed three main themes in the extant research: raising awareness, developing tools, and evaluation. As Figure 6 shows, a majority of papers were related to the theme of assessing and evaluating green IS practices. In comparison, just over a quarter focused on developing tools to support sustainability initiatives, and one in five sought to raise awareness about the relationship and interdependencies between IS and environmental sustainability. In addition to these themes, we also found a small proportion of papers that were more reflexive in nature.

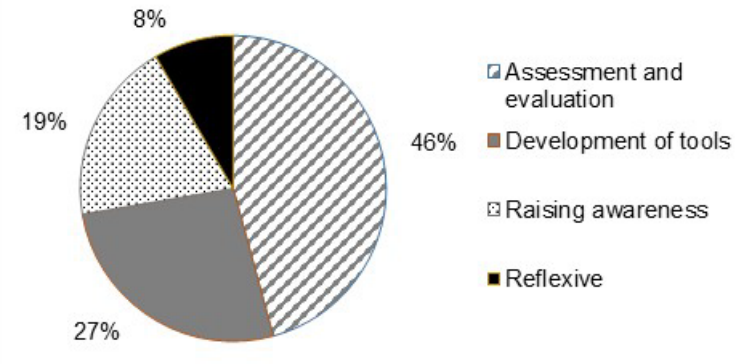

Figure 6. Proportion of Green IS Papers by Theme

4.2.1 Raising Awareness

Approximately one-fifth of the papers in our sample focused on raising awareness about environmental issues as they relate to information technologies and systems. In fact, such efforts pre-date our sample. As early as 1990, we can cite Davis, Stoms, Estes, Scepan, & Scott (1990) who tried to establish an IS approach to preserving biodiversity. In addition, Eckel, Fisher, and Russell (1992) explain the business and environmental opportunities of an environmental performance-measurement system, and Healy (1995) points out the controversial legitimacy of science and technology as solutions to sustainability problems. In our opinion, one could consider these papers early undertakings of what we now call green IS research.

The theme of raising awareness continued to gain strength in the first decade of the 21st century. Guide, Jayaraman, Srivastava, and Benton (2000) highlight the emergent and expanding phenomenon of profitable, environmentally sustainable business and the potential role of IS in achieving these objectives. We observed more concentrated efforts several years later to address the general lack of interest of IS research community with respect to the sustainability problem (El-Gayar & Fritz, 2006; Elliot, 2007; Molla, 2008). For instance, Elliot (2007) questions the relevance of environmentally sustainable information and communications technologies and whether it is a critical topic for IS research. It is also around this time that a major academic paper uses the term green IS for the first time (Molla, 2008). The effect of the green IS label likely played a dual role: it helped to create visibility and boundaries around this research domain and provided a certain degree of legitimacy for researchers seeking to do work in this area. Many of the top journals also contributed to raising awareness around the concept of green IS by publishing a variety of diverse research agendas (e.g., Dedrick, 2010; Elliot & Binney, 2008; Jenkin et al., 2011b; Lei & Ngai, 2012) and special issues on the subject (e.g., Sarkis et al., 2013).

As the general awareness of the relationship between information systems and sustainability has risen, research in this stream has become more nuanced. In recent times, different topics of research have started to emerge. For instance, Stahl, Eden, Jirotka, Coeckelbergh (2014) describe the concept of responsible research and innovation (RRI). RRI aims to ensure the desirability and acceptability of future research outcomes in respect of the challenges faced by humanity, of which environmental sustainability is one. Such work demonstrates the field's increasing maturation and provides a foundation for green IS research to tackle other themes.

4.2.2 Assessment and Evaluation of Green IS Practices

The second major theme we found in the green IS literature relates to questions of a firm's motivation and readiness to adopt Green IS. We describe this theme as "assessment and evaluation" because of its focus on analyzing firms' and individuals' current practices in relation to sustainability. Along this line of

thinking, several studies have focused on firms' motivations for adopting green IS (e.g., Molla, 2008, 2009; Molla & Abareshi, 2012; Molla et al., 2008) and the level of their adoption (e.g., Bose & Luo, 2011; Cai, Chen, & Bose, 2012, 2013). Firms' adoption to this new type of IS depends on a set of factors that can vary substantially from one organization to the next. Among these factors, managers' decisions have a great influence regarding organizational compliance with respect to the production of green products (Seidel et al., 2013). Organizations may also be subject to institutional pressures to adopt green IS and to develop green products (Butler, 2011). Employees' perceptions and leadership capabilities also play a role in the organization's adoption of IS to support green initiatives (Jenkin et al., 2011b; Tan, Pan, & Zuo, 2015).

In this theme, researchers have also addressed the question of trade-offs between financial and environmental performance. Achieving a balance between environmental and financial performance is related to green IS alignment within firms' other functions such as marketing and manufacturing (Ryoo & Koo, 2013). Assessing this balance of environmental performance (Green, Zelbst, Meacham, & Bhadauria, 2012; Rahman & Akhter, 2010; Wang, Chen, & Benitez-Amado, 2015) and financial performance (DesAutels & Berthon, 2011; Hertel & Wiesent, 2013) is a major subject IS researchers have studied to answer the emblematic question: does it pay to be green (Hertel & Wiesent, 2013)? However, one cannot properly assess something without proper metrics. The real difficulty according to Hecht (2003) is to have a comprehensive set of sustainability indicators that includes monetary and environmental and social aspects and that allows an organization to keep track of its efforts. Taking a somewhat different approach, Huang, Tsai, and Lin (2010) develop a software tool to measure environmental vulnerability. They argue that assessing and monitoring eco-environmental vulnerability is an important task in decision support and policy making.

As green IS practices evolve, this theme continues to emerge as an important research stream that aims to inform the researchers' community of the new practices and evaluate their potential to resolve sustainability issues.

4.2.3 Development of Tools

The third major theme of green IS research that we found in our sample concerns the development of IS tools for integrating sustainability into organizations. Here, the research has largely followed two major directions: a solution-oriented (or design science) approach (e.g., Loock, Staake, & Landwehr, 2011; Watson et al., 2011b), and a behavioral-science approach (e.g., Kranz, Gallenkamp, & Picot, 2010; Loock, Staake, & Thiesse. 2013). While the solution-oriented approach aims to develop tools that are directing solutions to a particular problem, the behavioral-science approach aims to solve problems by changing people's behavior.

This research demonstrates that using green IS can enhance individuals' and organizations' sustainable practices (Rickenberg, Koukal, & Breitner, 2014; vom Brocke et al., 2013). For example, using IS can encourage individuals to make more sustainable behavioral choices (Ijab, Molla, Kassahun, & Teoh, 2010), while, on the organizational level, virtualization and remote work (Bose & Luo, 2011) enables organizations to meet compliance imperatives and social norms related to organizational responsibilities for more environmentally responsible behaviors (Butler, 2011). In the solution-oriented stream, researchers emphasize how green IS can become an integral part of business processes (Möller & Schaltegger, 2005), how green IS can develop firms' capabilities to adopt and practice sustainability (Angeles, 2013; Jeffers & Joseph, 2009; Petrini & Pozzebon, 2009), and how firms can design new techniques (Benitez-Amado, Perez-Arostegui, & Tamayo-Torres, 2010; Dao, Langella, & Carbo, 2011; Zhang, Liu, & Li, 2011) .

Researchers have also significantly emphasized the importance of information and how it can be used to enhance transparency around environmental concerns and support better decisions (e.g., Seidel et al., 2013). This research tackles the problem that traditional management decision making tools are unable to integrate environmental aspects (Bengtsson & Ågerfalk, 2011; Gharagozlou & Adl, 2012).

4.2.4 Reflexivity

In our analysis, we found a small set of papers that displayed traits of deeper reflexivity (e.g., Loveday et al., 2008). As we elaborate in Section 6, reflexivity refers to a state of self-questioning and reconstructing through a dynamic of self-analysis (Déry, 2009). Research in this theme may be motivated and enabled by rising awareness of environmental issues and the special appeals for green IS research and practices.

Papers that represent this theme question whether IS, considering that it is itself a major contribution to the problem, can be a viable solution to environmental sustainability (Berthon & Donnellan, 2011; Markus & Mentzer, 2014). Along similar lines, Patrignani and Whitehouse (2015) suggest a "slow tech approach" to investigate the sustainability of IS in the long term and to rethink its impacts on society and the planet.

4.3 Summary

In summary, we observe that the green IS literature has grown and evolved substantially over the last fifteen years. The field has made significant progress in building awareness around the need to address sustainability challenges through applying IS, understanding factors influencing the adoption and use of Green IS, and building tools to support organizations' sustainability goals. In addition, we see increasing maturation in green IS research as scholars approach research questions from different perspectives, including those that are more reflexive in nature.

5 Patterns of the Modernity Perspective in Green IS Research

Returning to the conceptual framework of the modernity tetrahedron (see Figure 1), we now assess the manifestation of the modernity perspective in green IS research. Even though green IS scholars have investigated a diverse range of subjects, our analysis shows common approaches to environmental issues consistent with modernity. Of the six patterns of modernity we initially identified, we identified four in the green IS literature (Table 1). We did not find evidence of the two patterns related to the nature pole and the political surface. With respect to the former, unlike the modernity perspective, green IS research aims to protect and save nature rather than take advantage of it and control it. As for the latter, we found that green IS research has not addressed the question of power of laws and regulations. Instead, the importance of laws filters through the priority given to business goals to comply with the legal pressures to enhance sustainability.

5.1 Importance of the Individual

The green IS literature has emphasized the important role of individuals' participation in addressing sustainability issues (see Table 4), which one can see as a pattern of modernity that emphasizes individuals' ability to solve the problems of their societies. For instance, Melville (2010a), in his research agenda, emphasizes the importance of individuals' beliefs in shaping organizational and societal actions that contribute to sustainability through the beliefs-actions-outcomes (BAO) framework. In a similar way, Molla, Abareshi, and Cooper (2014) suggest that environmental sustainability in relation to IT problems requires bottom-up actions from IT professionals as members of the broader social system. In their professional roles, IT professionals can contribute to sustainability by creating knowledge and innovative green IT solutions (Molla et al., 2014). Employees' perceptions and leadership capabilities also play a key role in the adoption of IS to support green initiatives (Butler, 2011; Tan et al., 2015). Thus, the above studies view individual actions as being central to shaping macro-level actions and initiatives. In addition to the bottom-up actions of individuals, top-down initiatives are also required. Top-down initiatives refer to actions taken on the organizational level. In this regard, Seidel et al. (2013) emphasize the great influence managers' decisions have on compliance to sustainability requirements for green products.

Researchers also see individuals' rationality in understanding the impact of their behaviors as an important factor in moving toward a more sustainable future for not only individuals but also organizations, governments, and society as a whole (Elliot, 2011). The view that providing individuals with more information about their consumption and activities will ultimately lead them to change their behaviors and environmental impacts has gained a foothold in the green IS research (Ijab et al., 2010; Wiegmans, Beekman, Boschker, Dam, & Nijhof, 2003). For instance, Watson, Boudreau, and Chen (2010a) call for research on pro-environmental personal computing actions to help consumers better evaluate their impact on the environment and make different lifestyle decisions. In presenting the cases of three successful green IS systems, Watson, Boudreau, Chen, and Sepúlveda (2011a) state that "information is a key ingredient for increasing the efficiency of energy consuming systems. Given access to the right information at the right time, energy reducing behavioral changes can be facilitated and energy consuming resources can be more efficiently managed" (p. 59). Researchers have also considered IT's potential to provide meaningful information in the context of the emerging mobile platform (Pitt, Parent, Junglas, Chan, & Spyropoulou, 2011) and persuasive systems (DiSalvo, Sengers, & Brynjarsdóttir, 2010).

Table 4. Importance of the Individual in Solving Environmental Issues: Selected Examples of Modernity Patterns in Green IS Research

Examples found in green IS research	References
The importance of individuals and their beliefs, perceptions, capabilities, and innovativeness in shaping organizational and societal actions (bottom up)	Melville (2010a), Molla et al. (2014), Benitez-Amado et al. (2010), Tan et al. (2015)
Influence and power of individuals within organizational structures (top down)	Seidel et al. (2013)
Role of individuals' rationality in understanding the impact of their behaviors based on relevant information	Elliot (2011), Ijab et al. (2010), Wiegmans et al. (2003), Watson et al. (2011a), Watson et al. (2010a), DiSalvo et al. (2010), Pitt et al (2011)

In conjunction with information and rationality, research has also highlighted the role of individuals' creativity and innovativeness in enabling sustainability. For example, Bernitez-Amado et al. (2010) suggest that IT technical and human capabilities for increasing employees' empowerment can enable them to adopt more creative and sustainable behavior.

As this brief discussion demonstrates, green IS research views individuals as having an essential role and power for changing the trajectory of environmental degradation through their information-based, rational decision making with respect to their personal green behaviors. This finding is consistent with the modernity perspective. However, researchers have not always seen this importance given to individual power to move towards sustainability in a positive way. Brynjarsdottir et al. (2012) suggest that this perspective can limit our thinking by framing sustainability exclusively in the sphere of individuals and their interrelationships. Thus, we may need alternative perspectives (see Section 6).

5.2 Science as the Main Source of Solutions

Trust in scientific advancement as ultimate source of solutions to society is a second pattern of modernity that we observed in green IS literature (see Table 5). As we note previously, green IS tends to be aligned with a transformation paradigm, and the green IS literature often reflects the call to action through scientific research (e.g., vom Brocke et al., 2013; Watson et al., 2012). One can observe this pattern dating back to the early publications on green IS, and it is still strong today as scholars continue to place a priority on solution-oriented green IS research (e.g.,vom Brocke et al., 2013; Watson et al., 2010b; Watson et al., 2012). Researchers consider green IS, as an applied science, to be an ideal candidate for providing solutions to tackle this important challenge (Rickenberg et al., 2014; Seidel et al., 2013; vom Brocke et al., 2013), much in the same way as it helped to advance other domains of life (Melville, 2010a).

Interestingly, the literature's emphasis on IS solutions seems to be in part motivated by the IS field's (including researchers and practitioners) trying to rectify a part of the problem that it helped to create. A popular report published in 2008 has suggested that IT was responsible for two percent of global greenhouse gas emissions (Climate Group, 2008). This report provided tangible targets for the field: green IS aims not only to reduce the two percent through green IT but also to address the remaining 98 percent of emissions through innovative IS applications (Dedrick, 2010). Achieving such objectives is not a trivial exercise and requires significant effort, particularly in face of growing dependence on information and communications technologies in our homes, organizations, and societies (Loveday et al., 2008; Røpke, Christensen, & Jensen, 2010). Many have recognized the double-edged sword of green IS or what Berthon and Donnellan (2011) refer to as a "paradox". On one hand, green IS has the potential to reduce energy consumption, but, at the same time, it necessarily adds to the sustainability challenge because of its high energy consumption (Berthon & Donnellan, 2011; Climate Group, 2008). Reacting to the challenges posed by the paradox of green IS, researchers have proposed research agendas based on the view that we need science to solve this problem. These agendas suggest multilevel changes in firms' IT and processes (e.g., Green et al., 2012), political programs (Lee et al., 2013), and behaviors (Molla et al., 2014).

Table 5. Science as the Main Source of Solutions: Selected Examples of Modernity Patterns in Green IS Research

Examples found in green IS research	References
The call to action through scientific research and the establishment of research agendas in the perspective that science is needed to solve the problem of sustainability.	vom Brocke, Loos, Seidel, & Watson (2012), Watson et al. (2012), Green et al. (2012), Molla (2013), Lee, Park, & Trimi (2013)
Placing a priority on solution-oriented green IS research.	vom Brocke et al. (2013), Watson et al. (2012), Watson et al. (2010a), vom Brocke et al. (2012) Richenberg et al. (2014), Seidel et al. (2013), Melville (2010a)
Addressing the green IS paradox: green IS aims to address the 2% through green IT and address the remaining 98% of emissions through innovative IS applications	Dedrick (2010), Berthon & Donnellan (2011)
Use of expert knowledge to help companies improve their environmental sustainability	Bolívar (2007), Davis et al. (1990), Grant, Seager, Massard, & Nies (2010), Morhardt (2010), Bengtsson & Ågerfalk (2011), Gharagozlou & Adl (2012)
Feedback driven by expert knowledge and artificial sciences solutions	Kranz et al. (2010), Loock et al. (2011)

Another important element of the modernity pattern related to science as the solution to sustainability is the emphasis on the artificial sciences. Artificial sciences concern artificial or man-made artifacts (Beckman et al., 2002). As Beckman et al (2002, p. 13) state: "While the natural sciences are interested in how things are, the sciences of the artificial are concerned with how things might be—with design". IS are among the human artifacts studied through artificial sciences approaches. Therefore, it is not surprising to see this pattern of modernity also reflected in green IS research, particularly when we consider the outlets that have been most prominent in publishing this work (Table 2). Specifically, we observe that green IS research emphasizes expert knowledge as the main characteristic of artificial science approach. For example, researchers have called for green IS research to move toward a solution sciences approach and away from the larger IS field's dominant social sciences paradigm (Watson et al., 2010a).

Research that explores the use of expert knowledge further evidences the artificial sciences approach in green IS literature. One may mobilize expert knowledge to help companies improve their environmental sustainability (e.g., Bolívar, 2007; Davis, Nikolic, & Dijkema, 2010; Grant et al., 2010; Morhardt, 2010) and to build informational frameworks to better support managerial decisions (Bengtsson & Ågerfalk, 2011; Gharagozlou & Adl, 2012). Using calculations, measurements, control of energy consumption, and environment degradation reflect a reliance on specific expertise—an important attribute of modernity (Déry, 2009).

Finally, several green IS papers (e.g., Kranz et al., 2010; Loock et al., 2011) highlight the importance of feedback information. To generate feedback, one requires expert knowledge to process specific calculations and evaluation based on sensor technologies to track energy consumption. Highly specialized, these technologies constitute expert systems. Thus, we observe that, in general, green IS research has tried to compose solutions for societal and business problems using specific expert knowledge. By exploiting knowledge gained about sustainability, green IS produces new knowledge through an infinite cycle of reassessing self-generated problems.

In summary, the modernity pattern related to science as the source of solutions for sustainability is prevalent in the green IS research. The modernity perspective views science as the authority that is supposed to hold the truth and way forward. However, Healy (1995), analyzing the weight of science and technology solutions to sustainability problems, points out the controversial legitimacy of science and technology as solutions to sustainability problems. It can be part of the solution but must operate in collaboration with other perspectives.

5.3 Reliance on Technology

The third pattern of the modernity perspective that we observed in the green IS literature was the high reliance individuals and society place on technology (see Table 6). In green IS research, multiple scholars have highlighted technical efficiency to solve sustainability issues. For example, research related to

environmental management systems and carbon management solutions (e.g. Perez, Roncoli, Neely, & Steiner, 2007; Walker & Cass, 2007), which focus on calculating individual or organizational footprints, reflect this emphasis. Using these calculations assumes an immense trust that technology is able to accurately capture the level of the environment's degradation.

Table 6. Reliance on Technology: Selected Examples of Modernity Patterns in Green IS Research

Examples through green IS research	References
Technical efficiency to solve sustainability issues through quantifying environmental impacts.	Perez et al. (2010), Walker & Cass (2007), Loveday et al. (2008), Watson et al. (2010a)
Using technology to enhance optimization, dematerialization, behavioral change, and the creation of metrics.	Zapico, Brandt, & Turpeinen (2010), Goebel & Callaway, 2013
Firms' investments in IT infrastructure and management practices developed in the IT department to increase firms' efficiency.	Benitez-Amado & Walczuch (2012), Watson et al. (2010a), Capra & Merlo (2009), Mines, Brown, & Lee (2007)
Creating technical tools to monitor environmental efforts such as corporate sustainability reports.	Loeser (2013), Watson et al. (2012)

Elaborating on this idea, Loveday et al. (2008) suggest that IT opens ups new opportunities for energy management due to its capacity for monitoring and control. In this way, IT can enhance the overall system's energy and environmental performance. More specifically, organizations are starting to extensively use renewable energy technologies for space heating, water heating, and power generation as a means to achieving targets for carbon reduction (Loveday et al., 2008).

Green IS studies see technologies as a means towards optimization, dematerialization, behavioral change, and the creation of metrics that help improve environmental decision making (Loveday et al., 2008; Zapico et al., 2010). Researchers have shown firms' investments in IT infrastructure and management practices developed in the IT department to increase efficiency (referred to as IT capabilities) to play an important role in firms' environmental strategy (Benitez-Amado & Walczuch, 2012). One can link this pattern to a general technology imperative (Markus & Robey, 1988) in which technology is an exogenous force that determines organizations' behavior. The technology imperative involves "utopian or un-critical assumptions about the necessity of technological development or about the abilities of technology (for example, in its ability to deliver large cost savings, transparency, participation, or democracy)" (Flak & Rose, 2005, p. 655).

Similarly, other streams of research in green IS, such as energy informatics (e.g., Watson, Williamson, Boudreau, & Li, 2010b), and green IT (e.g., Capra & Merlo, 2009; Mines, 2008), direct our attention to other means of achieving technical efficiency. Seidel, Recker, Pimmer, and vom Brocke (2014) highlight the importance placed on technical efficiency in the context of enterprise resource planning solutions. Alternatively, the development of the solar car provides another example of using technology for sustainability (Goebel & Callaway, 2013).

Finally, growing awareness of environmental issues has led to the creation of numerous managerial tools such as corporate sustainability reports (Loeser, 2013). Sustainability has become a new business megatrend with a primary focus on the energy efficiency via technology to reach sustainability.

5.4 Growth as the Ultimate Goal of Business

The final pattern of modernity that we observed in green IS research is the view of growth as the ultimate goal of business enterprises (see Table 7). As Figure 3 shows, a large majority of green IS research is situated at the organizational level. These results are consistent with those of others who suggest that green IS research has a strong focus on addressing organizational needs and goals reframed by environmental laws and requirements (Pernici et al., 2012). This focus may be the result of an underlying influence of modernity that places great importance on business and economic growth and development. Seidel and Recker, in a panel discussing (Loos et al., 2011) the impact of green IS, have argued that we need green IS to support sustainable business processes, while Elliot (2011) explains the focus on business transformation to solve sustainability issues by the fact that business has a potential capacity for innovation and global change.

Table 7. Growth as Ultimate Goal of Business: Selected Examples of Modernity Patterns in Green IS Research

Examples through green IS research	References
Emphasis on sustainable of business processes as a mechanism for meeting both business growth and performance objectives and sustainability	Seidel and Recker (2011), Green et al. (2012)
Business as a core driver for sustainability due to its capacity for innovation and change	Elliot (2011)
Assessment of the balance of environmental performance and financial performance was a major subject to IS researchers	Rahman and Akhter (2010), Hertel and Wiesent (2013), Fuchs (2008)

The literature suggests multiple avenues by which green IS can support businesses' growth objectives. For instance, researchers have found green supply chain management (GSCM) practices to be both environmentally necessary and good business (Green et al., 2012). Molla (2013) found that green IS and green IT adoption in firms has been selective despite their recognition that sustainability is important. This finding suggests that it is difficult for decision makers to find a balance between business and environmental objectives when it comes to the question of investing and implementing green IS. This balance issues has been a major subject for green IS research (DesAutels & Berthon, 2011; Green et al., 2012; Hertel & Wiesent, 2013; Rahman & Akhter, 2010; Wang et al., 2015).

The continuing importance that researchers place on traditional business outcomes such as profitability and growth when examining green IS is in line with the modernity perspective reflected in the capitalistic systems of modern business. Fuchs (2008) acknowledges that a sustainable society indeed needs IS and knowledge to enable a good life and economic security for all human beings. But he also adds that "achieving a sustainable information society costs, it demands a conscious reduction of profits by not investing in the future of capital, but the future of humans, society, and nature" (Fuchs, 2008, p. 1).

5.5 Summary

We found four main patterns of modernity in the extant green IS research. Green IS research has invested substantial effort to help contemporary organizations ensure their growth in a more environmentally responsible way. The modernity perspective offers a convenient environment for organizations to prosper under free-market and capitalist paradigms, and it has enabled the birth and growth of the new green IS field. However, as various green IS researchers have also noted, sustainability is a complex challenge that needs to be addressed from its various stakeholders and different perspectives. We seek to extend this line of thinking by exploring how a more reflexive, hyper-modernity perspective may help to spark innovative and impactful green IS research going forward.

6 Green IS Research: Beyond Modernity

Since its inception, the green IS research field has contributed to increasing awareness about environmental issues and the development of tools, approaches, and knowledge for advancing environmental sustainability. By examining the development of this field through the lens of modernity, we can shine new light on the predominant themes and approaches. We found that patterns of modernity perspective manifested in green IS research to a degree that should push us to rethink our vision. As various other authors have suggested (e.g., Brynjarsdottir et al., 2012; Healy, 1995), continuing in the same path may limit our capability to more fully understand and tackle sustainability issues. When done according to the traditional modernity reason frame, our reflection-on sustainability is limited to a small portion of the problem. Sustainability itself is a new frame for solving complex and interrelated side-effects to achieve long-term societal development (Moore, Gelfand, & Whitsett, 2015; Voss et al., 2006).

As we discuss in Section 4, we uncovered evidence of reflexivity in green IS research, a perspective that is more aligned with hyper-modernity. Admittedly, this perspective is evident in only a small number of papers that question the direction of green IS research and invite other researchers to rethink and reflect on our real contributions to the sustainability challenge. Epistemologists describe hyper-modernity as a new type of modernity (Lipovetsky, 2004), and some sociologists have suggested that society has moved away from pure modernity toward hyper-modernity (Beck, 1992a; Déry, 2009; Giddens, 2013; Lipovetsky, 2004). A hyper-modern society is reflexive in all matters; in other words, it is continually reconstructing its foundations by questioning and analyzing its dynamic (Déry, 2009).

Many sociologists suggest that reflexivity is a natural consequence of hyper-modernity (Déry, 2009). Although this may be true, we suggest that the green IS research community could take a more proactive stance. Instead of transitioning to reflexivity as simple consequence of hyper-modernity, we argue that green IS researchers should master reflexivity and employ it purposefully to improve. Our first opportunity as researchers in this field is to commit to a reflexive approach in our methodologies, in the questions we ask, and the directions we undertake. To move toward a reflexive agenda of research, we can use the tetrahedron conceptual framework, replacing the modernity patterns with hyper-modernity patterns, as Figure 7 illustrates. In so doing, we create a conceptual framework as a guide for future research that questions how green IS impacts each of society's poles and surfaces. In other words, a reflexive agenda means every research pursuit should consciously and purposefully deal with all three poles and assess their interaction and mutual impacts. Pursuing this approach should lead to more diverse and, we hope, meaningful green IS research.

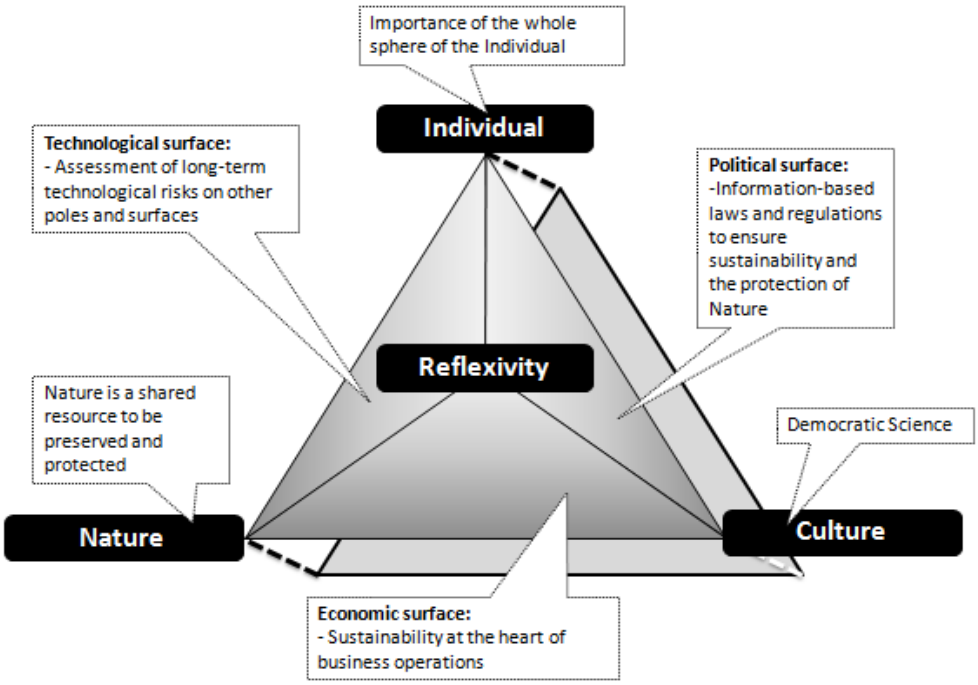

Figure 7. Conceptual Framework of Hyper-modernity Perspective for Green IS Research

6.1 Reflexivity as the Cognitive Operator

Using a hyper-modern view, green IS research should consider the poles and surfaces of society's tetrahedron differently than under a modernity perspective. The incorporation of self-confrontation in the society's institutions and dynamics is a pattern of hyper-modernity (Giddens, 2013). In addition, a hyper-modern society undertakes new efforts to solve self-created problems. Thus, instead of a focus on reason, the cognitive operator in a hyper-modern framework is reflexivity. Reflexivity applied in green IS research would lead to a self-questioning dynamic with respect to the field's advancement and future directions. Assuming reflexivity as the chief cognitive operator, Table 8 summarizes alternative patterns for the tetrahedron's poles and surfaces that could guide green IS research.

Table 8. Hyper-modernity Alternatives for Green IS Research

Pole or surface	Pattern of modernity	Alternative pattern in hyper-modernity	Description
Individual	Importance of the individual in solving environmental issues	Importance of the whole sphere of the individual	Importance of the entire environment in which the individual is embedded, including links with other poles and the impacts on the surfaces
Culture	Science as the main source of solutions and the emergence of artificial science approach	Democratic science	Democratic science is science constructed with society's other poles and surfaces
Nature	Nature as a reservoir of knowledge to be controlled	Nature is a shared resource to be preserved and protected	Nature should be considered in every aspect of the other poles and surfaces
Political	Importance of laws and regulations	Information-based laws and regulations to ensure sustainability and the protection of nature	IS can provide information needed to produce laws that ensure greater sustainability in other poles' and surfaces' operations
Economic	Growth as ultimate goal of business	Sustainability at the heart of business operations	Going beyond corporate sustainability concerns to include environmental and societal outcomes in a reframed view of performance
Technological	Reliance on technology	Assessment of long-term technological risks on other poles and surfaces	Technology should not be adopted unless its impacts on other poles and surfaces have been deeply analyzed

6.2 Individual, Culture, and Nature Poles

As compared to modernity, hyper-modernity puts pressure on the individual to be reflexive about their behaviors and their role in the society (Déry, 2009). Regarding the use of IS specifically, hyper-modern individuals are more selective and self-aware of the services IS can offer and their benefits and costs. Instead of focusing solely on fulfilling individual needs, reflexive individuals are highly connected to, and concerned about, diverse elements of their environment (e.g., business and political trends, society issues, sustainability) (Déry, 2009).

Adopting this pattern of hyper-modernity in green IS research would require changes to research designs and a move away from a central focus on the importance of individuals to the role of the individual as one pole embedded in the whole environment. Take, for example, a study that examined the use of a smart phone application to encourage an individual to adopt more environmentally responsible behaviors. The research could incorporate the whole sphere of individuals by studying the various contexts of their lives. At home, there may be significant mutual influences with the surfaces and poles of society. With reference to the technological surface, this research would need to assess the long-term risks of the smartphone application in use on not only the individuals personally but also the whole sphere. The research would also need to assess the influence of the intended behavior and its interaction with individuals' job environment (economic surface) and the society as a whole (the political surface). Although this type of research is broad in scope and, therefore, more complex to implement, we can take the first steps by examining cross-context influences of green IS on pro-environmental behavior (e.g., Corbett & Cherki El Idrissi, 2015). In sum, research conducted according to a hyper-modern perspective can gain deeper understanding of the whole environment of the individual and shed lights on phenomena that could not be seen from a modernity perspective.

With respect to the culture pole, under modernity's influence, green IS research emphasizes the idea that green IS is science's solution to sustainability problems. However, under hyper-modernity, green IS research would reflexively analyze modernity's consequences. As we discuss in Section 4, a reflexive approach is a systemic problem-solving approach that transgresses cognitive, evaluative, and institutional boundaries to create an interaction between different perspectives of problem analysis. Such an approach could help to reduce uncertainties associated with the sustainability challenge by covering a broader range of possibilities. In adopting this approach, the green IS field would acknowledge existing problems

and endeavor to build appropriate solutions. This could eventually lead, paradoxically, to other problems for which other solutions will have to be shaped (Déry, 2009). However, pursuing a reflexive approach to research design should reduce the risks of creating unanticipated problems.

To understand this change in reasoning, under reflexivity, science is not under researchers' limited purview. Rather, it is democratized to include all society members in a recursive way, which might be done by involving diverse stakeholders in the research process. Action research can be a good context for developing democratic science that not only is constructed from scientist's purview but also uses the contributions of the whole society. Reflexivity is intended to promote continuous reflection on society to move it toward to a better state (Voss et al., 2006). Consistent with this idea, Melville (2010b) argues that sustainability is a complex problem because it is multi-layered with uncertain interdependencies and nonlinearities and touches micro and macro levels of analysis. This argument implies we need a careful approach in terms of philosophical and methodological strands (Melville, 2010b). Related to this argument, democratic science is based on multidisciplinary research and defies high specialization. Elliot (2011) suggests the complexity of sustainability requires trans-disciplinary approaches. Trans-disciplinary research provides a major opportunity to avoid negative side effects due to high specialization in which each specialty has no way of communicating with others. Indeed, high specialization leads social actors to become experts in their fields and leaves no one able to give a comprehensive solution to a complex problem. In the same way, green IS research must not be limited to solving business sustainability problems. It should be directed to include the whole system forming society and linked with green IS (Hovorka & Corbett, 2012).

As with the other to poles, a hyper-modernity perspective also changes the view of nature. In particular, nature is not simply a set of resources to be owned and exploited but rather a shared resource worthy of preserving and protecting. Reflexivity brings higher awareness of nature problems. Through continuously confronting our practices, nature has gained a higher protection level in modernity, and it should continue to gain protection from society in hyper-modernity. For example, Hopwood, Mellor, and O'Brien (2005), present a classification and mapping of different trends of thought on sustainable development, their political and policy frameworks, and their attitudes towards change and means of change. This point of view is confirmed by Manning (2007) who calls for a mind shift in the methods used in reen IS research to bring a positive outcome in society. This positive outcome can most likely be achieved if green IS researchers enhance their self-understanding and transcend purely individual and organizational needs to address nature's needs and our planet's future.

6.3 Political, Economic, and Technological Surfaces

As with the poles, we suggest that adopting reflexivity as the cognitive operator will result in new patterns of hyper-modernity across the three surfaces. Hyper-modernity requires that institutions reconsider their practices because reflexivity is an institutional phenomenon (Déry, 2009), which means that it is infused through institutions adopting reflexivity and then filters down to influence other elements of society. On the political surface, we propose that the alternative pattern under hyper-modernity would be one that places a priority on information-based laws and regulations to ensure sustainability and the protection of nature. With respect to the economic surface, the idea of growth as the ultimate business objective would be replaced with sustainability at the heart of business operations. On both the political and economic surfaces, there is an important role for green IS research.

Already, we observe that green IS research is intertwined and interdependent with a variety of institutions, such as corporations, universities, and governments. On one hand, these institutions are participants in the conduct of scientific exploration whether through funding or providing research sites and data. Thus, researchers are highly dependent on these institutions for achieving their objectives. On the other hand, these institutions rely on the knowledge created through scientific endeavors to change their business practices, regulations, or behaviors in such a way as to be more sustainable. Based on the information that green IS can make available, these institutions could use reflexive strategies to increase their knowledge and to change patterns of behavior, which, in turn, could help shape new political and economic surfaces where sustainability is more fully considered (Watson et al., 2012). Further, green IS could provide mechanisms for reflexively analyzing laws and business practices and for continually reassessing the sustainability impacts of such actions.

Finally, with respect to the technological surface, a hyper-modernity pattern suggests that technology choices should be considered in the longer term. Various scholars have started to shed the light on the long-term consequences of relying on technology (Patrignani & Whitehouse, 2015) and the possibility that

we might over-look them (Pauleen, Dalal, Rooney, Intezari, & Wang, 2015). This situation should change with the adoption of the hyper-modernity perspective and more reflexive processes. These would allow us to analyze whether the technology is safe for the other poles and surfaces. We propose that green IS research should extend beyond the predominant view of building fixed, unambiguous, and controllable solutions to environmental sustainability, which reflects patterns of a rationalist solving approach. For example, Dedrick (2010) presents a catalogue of green IS solutions to organizations. These solutions are fixed (in contrast with progressive) products that limits sustainability problematic to the boundaries of the organization using that green IS solution. Because uncertainty and ambivalence are the basic characteristics of the sustainability challenge (Voss et al., 2006), green IS research should strive to develop a new way of thinking and acting that enables all possible sustainability "actors" to develop reflexive solutions (Voss et al., 2006).

7 Conclusion

As Moore et al. (2005) say: "to understand why technologies take the form they do, it is also necessary to understand the social interests that drive them and, in turn, derive from them" (p. 4). In the same manner, we, as IS researchers, need to be understanding the underlying perspectives of our environment and the impacts they have on our work. To this end, in this paper, we use the modernity perspective to explore the green IS research field's development and present opportunities for greater reflexivity. To conclude, we discuss the major contributions and limitations of our work.

7.1 Contributions

With this paper, we make two notable contributions to IS scholarship. First, we provide a historical narrative and analysis of the evolution of green IS research. Rather than looking at this development from a more common thematic approach, we take a novel approach by applying the modernity perspective. In so doing, we highlight how this perspective, common in our society and other management structures, is manifest in the domain of green IS research. We identify four specific patterns of modernity in green IS research. As other authors have noted, environmental sustainability is particularly complex and urgent field, which requires IS researchers to extend their epistemological horizons to contribute to its solution (Melville, 2010a). Understanding the underlying perspectives that underpin and influence our work provides a first step to novel thinking that lead to solutions that better address the complex and critical sustainability challenges in front of us.

Second, we develop a conceptual framework inspired by hyper-modernity and centered on reflexivity that could serve as a guide for future research. In our analysis of the extant green IS literature, we identified not only patterns of modernity but also the initial influences of hyper-modern reflexivity. From an epistemological perspective, there exists an implicit link between the modernity perspective and reflexivity associated with hyper-modernity, which our research brings to light in the context of green IS. By outlining various patterns of hyper-modernity in the conceptual framework, we are able to offer researchers new windows from which to view the relationships between society, sustainability, and information systems. At a practical level, the framework allows us to offer suggestions to researchers in terms of engaging more stakeholders, such as in conducting science democratically, transcending cognitive borders, and integrating trans-disciplinary research to enhance our collective abilities to address and resolve complex challenges associated with environmental sustainability.

7.2 Limitations

Despite these contributions, our work has several limitations. First, with respect to methodology, we did not conduct an exhaustive systematic literature review. However, our research interest was unique and required a more flexible approach. We believe our search of the literature provided necessary foundation to conclude the interactions between society's changes, modernity, and the advancement of green IS research. Another limitation is the fact that we are not epistemologists, which would give deeper insights of society and its interconnection with scientific research. In this regard, we focused not on developing new insights with respect to the modernity or hyper-modernity perspectives but rather to apply these perspectives as lenses to understand the progression and influences on green IS research. We feel our reading of the literature and understanding of the modernity perspective, combined with our experience in the domain of green IS research, allows us to contribute novel insights to the field. Third, practical limitations prevented us from discussing all the potential patterns of modernity and hyper-modernity. Those that we have presented herein represent those patterns that we feel are most appropriate given the

research's context and objectives. Nevertheless, consistent with the principal of reflexivity, we encourage other researchers to explore other patterns that may be manifest in the extant green IS research or which may provide fruitful avenues for approaching future research.

7.3 Summary

In the global society, there is growing consensus that environmental sustainability is an important objective. Humans are limited in their attempts to solve their problems regardless of the level of progress they strive to achieve. Considering that science creates solutions that become problems of tomorrow, green IS research should take a longer-term perspective and integrate a more critical eye to scientific solutions to the sustainability crisis. Research founded on the concept of reflexivity provides a new avenue of exploration and has an important a role to play in to ensure this objective for the benefit of all.

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