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ORIGINAL PAPER

Digitalization as a problem or solution? Charting the path for research on sustainable information systems

Daniel J. Veit[1] · Jason B. Thatcher[2]

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Abstract

Digitalization has permeated all aspects of human lives, economies, and societies. This transformation has been driven by the rapid growth in computing power, storage capabilities, and data transmission infrastructures. These changes have enabled innovations, such as cloud computing, artificial intelligence, smartphones, digitalized homes, (semi) autonomous vehicles, quantum computing, and more. Digitalization has further resulted in faster, more effective service delivery by many organizations. The phenomenon of digitalization relies on an increasingly finite supply of resources, such as crude oil, silicon, and energy. Over the past 150 years, humans have consumed as many natural resources as they have consumed in the past 20,000 years. In part, this increasing clip of consumption has been driven by digitalization, as novel, technology-based solutions, such as blockchain, supplant older, slower low-tech solutions, such as books and ledgers, to process data and create value. Digitalization's demand for resources may be leading us to an environmental abyss. Consider cryptocurrencies such as Bitcoin, whose electricity consumption is approximately equal to the energy needs of small nations such as Malaysia or Sweden. Such consumption evokes the question, is, "is more digitalization really better, or given the harm to the planet, is this one context where less is more?". In this paper, we develop a research agenda for understanding the full cost of digitalization and its impact on sustainability. We do so in three parts; first, we offer a crisp definition of sustainability; second, we offer a concise review of the digitalization and sustainability literature; and third, we offer suggestions for research that advances our understanding of how digitalization impacts sustainability.

Keywords Digitalization · Sustainability · Sustainable development · Environmental sustainability · Social sustainability · Economic sustainability · Green IT · Green IS

JEL Classification M00 · M15 · Q01 · Q55

✉ Daniel J. Veit
daniel.veit@uni-a.de

Extended author information available on the last page of the article

1 Introduction

In 1972, Meadows, Meadows, Randers, and Behrens argued in "The Limits to Growth" that absent changes in how we live, life as we know it, would end (Meadows et al. 1972). To support their argument, Meadows et al. used the World3 computer model to simulate possibilities for five factors – population, food production, industrialization, pollution, and consumption of non-renewable resources. The designers argued that demand for these factors grew exponentially while information technology's (IT) ability to address problems only grew linearly. Though frequently debated and often challenged, no one disputes Meadows et al. (1972) core contention – that people, societies, and industries must change their consumption patterns if we are to build sustainable economies.

While IT was discounted as a solution by Meadows et al., their work inspired the relatively young Green IT movement in the Information Systems (IS) discipline. In specific industries, such as the crude oil and petrochemical industry simulation models were crafted that predicted mankind's growth would result in global warming. Instead of inducing change to resource consumption patterns, the energy industry put profits from resources such as low-cost crude oil or coal before sustainability (Bonneuil et al. 2021). Perhaps, due to the low cost of energy, the information technology industry directed attention to building faster, more reliable solutions rather than sustainable technologies (Dao et al. 2011).

Some Green IT/IS researchers took up the Meadows et al. call and have directed attention to new technologies' environmental costs. For example, a frequently cited concern about blockchain and cryptocurrency is their vast and continuing energy demands (Truby 2018). Carter (2021) argues that "Bitcoin currently consumes around 110 Terawatt hours per year — 0.55% of global electricity production, or roughly equivalent to the annual energy draw of small countries like Malaysia or Sweden."

These researchers now question whether the value of new technologies outweighs their environmental impact. While technology is not bad, they argue that consumption-based approaches to technology have harmed society by increasing the digital divide, undermining the environment, and increasing energy consumption and toxic waste. Unfortunately, their complaints have fallen on deaf ears, and digital infrastructures now account for two percent of global greenhouse gas emissions (Dedrick 2010).

While some Green IS researchers, in line with Meadows et al. saw new technologies as problematic, other Green IS researchers suggest the effective application of information technology is a sustainable future. They study how to use IT to introduce efficiencies into economies and effectively transform how we apply IT in society (Watson et al. 2010). For example, a frequently cited case about blockchain shows its use for tracking perishable shipments leads to less food spoilage (IBM 2021). While acknowledging power consumption, electronic waste, and other issues, these scholars direct attention to how IT can be used to address resource consumption and realize goals such as reducing food waste or increasing energy efficiency (Watson et al. 2008; Elliot 2011; vom Brocke et al. 2013).

The competing views on Green IT and sustainability suggest that technology is both part of the problem and part of the solution (Fuchs 2008; Dedrick 2010; Berthon and Donnellan 2011; Wang et al. 2015). We believe there is merit in both approaches. Without critically questioning the challenges that new or existing IT poses to the environment, IS research and practice might mindlessly support using technologies in all contexts with far-reaching negative environmental externalities. By introspecting on how to use IT to support sustainability, IS research and practice support the effort to build environmentally sustainable economies and societies. By offering a diagnosis of the problem and charting a path to solutions, the IS literature could contribute to a robust understanding of how to address Meadows et al. (1972) concerns and help build a sustainable future for our planet.

To advance the IT and sustainability literature, this paper pursues three goals. First, the paper offers a crisp definition of sustainability for IS research. We do so by concisely reviewing the intellectual foundations of sustainability, noting that the broader literature directs attention to economic, social, and environmental dimensions of sustainability. Thereby, we observe that the IS literature focuses on environmental sustainability. Second, we provide a summary of IT and sustainability papers found in leading IS journals. We report the results of a systematic literature review and describe how sustainability has been treated in relevant IT-focused journals. Finally, we offer an agenda for IS and sustainability research. In doing so, we suggest there remains a need for additional work that more effectively connects IT use to environmental externalities as well as IT's application to improve sustainable development.

2 Sustainability in IS research

Focusing on IS research, 'sustainability' has been defined in several ways in the literature. This is not surprising considering the nuanced and ambiguous nature of the concept. At the same time, it is striking since Elliot (2011) has offered a general definition. Although our primary concern in this opinion piece will be to discuss the IS literature that examines *environmental* sustainability, as this appears to be the major focus of IS scholars, we encourage future researchers to offer a crisp definition of how they define sustainability in their work. By doing so, authors ensure a common understanding of their work and its implications. To provide a starting point for such crisp definitions, we first review definitions of sustainability and then we proceed to a review of the IS literature. By doing so, we set the stage for directions for future IS research that extends beyond environmental sustainability to include social sustainability and economic sustainability.

2.1 A holistic perspective on the definitions of sustainability

The term "sustainable development" has initially been popularized in the Brundtland Report (1987) issued by the UN World Commission on Environment and Development (WCED). Since then, the terms sustainability and sustainable development have been increasingly used interchangeably (Johnston et al. 2007). Yet, no common and interdisciplinary definition exists for both expressions (Purvis et al. 2019). There are more than 300 different definitions of sustainability and sustainable development (Johnston et al. 2007). Many scholars adopt the Brundtland Report's definition (e.g., Dyllick and Hockerts 2002; Elliot 2011), which defines sustainable development as "the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission 1987, p. 43).

While the Brundtland Report's definition conveys sustainability's complex nature in a simple and compact manner (Elliot 2011), it suffers from at least three shortcomings. First, due to its simplicity, it is limited in its applicability in an organizational context (Dao et al. 2011). Second, the equivocality of the term "development" coupled with its insufficient specification in the definition leads to pluralism in interpretations that vary with the research discipline (Geissdoerfer et al. 2017). Third, the definition lacks clarity about what exactly "needs" are, how future "needs" differ from those of the present generation, and whose "needs" ought to be prioritized (Redclift 1993; Starik and Rands 1995).

To move beyond the Brundtland Report's shortcomings, scholars typically tailor sustainability's definition to their particular discipline and the "needs" of their respective contexts. When defining agricultural sustainability, for instance, Tilman et al. (2002) refer to "societal needs for food and fibre, for ecosystem services, and for healthy lives" (p. 671). In contrast, in their definition of corporate sustainability, Dyllick and Hockerts (2002) address the "needs of a firm's direct and indirect stakeholders" (p. 131). Thus, the definition provided by the Brundtland Commission represents a viable description of sustainability but requires customization in order to apply it in specific research domains.

Sustainability research often considers three issues: environmental, economic, and social (Malhotra et al. 2013). Referred to as the three pillars approach or triple bottom line (Elkington 1997, 2018), this view of sustainability extends the conventional financial bottom line, i.e., economic sustainability, to consider environmental and social dimensions of sustainability.

Economic sustainability can be understood as a two-dimensional concept. Economic sustainability refers, on the one hand, to the firm-centered conventional bottom line of financial profitability and, on the other hand, to the broad-based improvement of economic well-being and the standard of living (Sheth et al. 2011).

Social sustainability is often perceived as vague due to its multifaceted nature (Littig and Griessler 2005; Gimenez et al. 2012; Missimer et al. 2017), thereby complicating the process of arriving at an all-encompassing definition (McKenzie 2004; Schoormann and Kutzner 2020). However, descriptions of the social dimension typically involve sustainable and healthy communities that are equitable, inclusive, and democratic (Schoormann and Kutzner 2020; Khan et al. 2021) as well as the ability of organizations to increase the social resources of those communities to ultimately achieve a life-enhancing condition (Dyllick and Hockerts 2002; McKenzie 2004).

We follow Elliot (2011) and define environmental sustainability as "stakeholder behavior impacting on the natural environment that meets the needs of the present without compromising the ability of future stakeholders to meet their own needs" (p. 207). By building on the Brundtland Report, Elliot offers a simple definition that affords opportunities to investigate how the actions of key stakeholders, namely individuals, groups, organizations, and governments, impact the sustainability of society and ecosystems. Further, Elliot (2011) takes a normative stance, suggesting that environmental sustainability serves as a prerequisite for achieving the social and economic dimensions (see Fig. 1).

The tripartite sustainability perspective acknowledges environmental, economic, and social issues intertwine, often visually presenting the dimensions in either three concentric or intersecting circles (Purvis et al. 2019). By doing so, the sustainability literature acknowledges that the pillars depend on each other in positive and negative ways (Hansmann et al. 2012). On the one hand, advocates of the concentric model consider the economic and social dimension to be dependent on the environmental dimension (e.g., Elliot 2011), whereas, on the other hand, advocates of the intersecting representation (e.g., Dao et al. 2011) regard the three dimensions to be of equal priority (McKenzie 2004).

2.2 Contextualized definitions for the IS domain

Most frequently, IS research directly focuses on environmental sustainability and indirectly focuses attention on economic (e.g., Ganju et al. 2016) and social sustainability (e.g., Díaz Andrade and Doolin 2016). Environmental IS for sustainability research most often focuses on Green IT and Green IS practices and strategies (e.g., Henfridsson and Lind 2014; Hedman and Henningsson 2016; Loeser et al. 2017). While the concepts of economic and social sustainability can be found in the IS literature, authors rarely use sustainability or sustainable development as the lens for their work (Schoormann and Kutzner 2020). For example, one could argue that most research on digital platforms or e-government is about building sustainable economies and societies. However, if one were to ask the authors in these spaces, they would acknowledge their focus is more on market or organizational efficiency and effectiveness than on building a sustainable system.

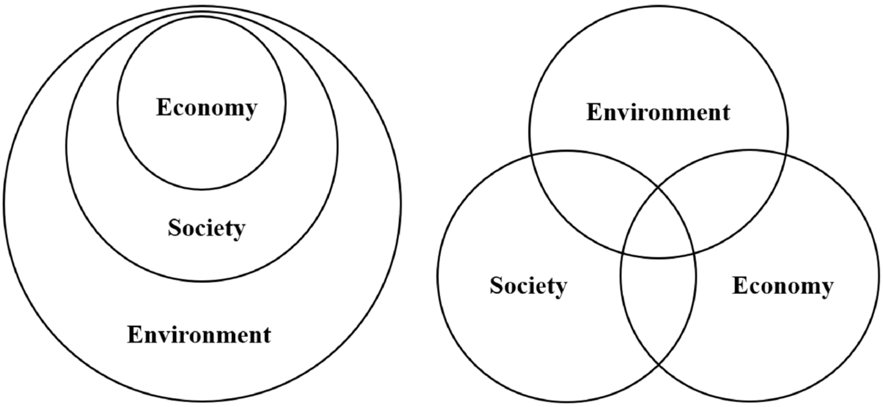

Fig. 1 Three pillars of sustainability. Adopted from Purvis et al. (2019, p. 682)

Table 1 summarizes literature-based definitions of sustainability. We offer a contextualized definition for the domain of IS, based on our review of the IS for sustainability literature that appears in the next section.

3 The current state of environmental sustainability in IS research

To understand how the IS discipline studies sustainability and identify opportunities for advancing that literature, we conducted a systematic literature review (Webster and Watson 2002) in the so-called 'basket of eight' which includes the following journals: *European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems, Journal of the Association for Information Systems, and Management Information Systems Quarterly*. We searched multiple databases, including EBSCOhost, ScienceDirect, AISeL, and ProQuest. In our searches, we used broad keywords, namely "sustainability" and "sustainable." To bound our search, we set March 01, 2022, as the deadline for the review. Other than specifying the keywords on sustainability, we did not impose any restrictions. We included articles, research notes, editorials, issues, and opinions, as well as special issue introductions. After screening titles and abstracts as well as removing duplicates, we eventually obtained 16 papers from EBSCOhost, 11 from ScienceDirect, five from AISeL, and, three from ProQuest. We performed forward and backward searches and identified three additional papers (Webster and Watson 2002), thereby arriving at a total of 37 papers.

3.1 Classification of the existing literature

We found that IS researchers largely focus on environmental sustainability and leave the social and economic dimensions of sustainability unexamined (Schoormann and Kutzner 2020). The few studies that specifically mention the social and economic pillars, do so as part of discussing the triple bottom line (Elkington 1997) and consider all three dimensions simultaneously (Petrini and Pozzebon 2009; Melville 2010; Bengtsson and Ågerfalk 2011; Dao et al. 2011; Corbett and Mellouli 2017). All 37 identified papers consider environmental sustainability in some way, so we classified them according to their impact on reducing human activities' environmental footprint (as shown in Fig. 2).

To do so, we adopt the value space classification of Malhotra et al.'s (2013) sustainability review, which used the following categories: "*conceptualize* (review papers, conceptual frameworks, etc.); *analyze* (case studies, ethnographic analyses, quantitative empirical analyses, hermeneutics, etc.); *design oriented* (design science); or *impact oriented* (implementation and sustainability impacts using action research, in vivo real-time approaches, etc.)" (p. 1266). In their review, they obtained a total of 14 results within the IS basket of eight, while Gholami et al. (2016) identified 8 additional studies three years later. We note that we found 13 additional studies since 2016, thereby totaling 35 papers, excluding the publications

Table 1 Definitions of sustainability

Concept	Description	References
Economic sustainability	Economic sustainability refers, on the one hand, to the ability of organizations to guarantee at any time cashflow sufficient to ensure liquidity while producing a persistent above-average return to their shareholders and, on the other hand, to the economic interests of external stakeholders, such as a broad-based improvement in economic well-being and standard of living	Dyllick and Hockerts (2002); Sheth et al. (2011)
Social sustainability	Social sustainability refers to stakeholder behavior adding value to the communities within which they operate by increasing the human capital as well as furthering the societal capital to achieve a life-enhancing condition within these communities	Dyllick and Hockerts (2002); McKenzie (2004); Elliot (2011)
Environmental sustainability	Environmental sustainability refers to stakeholder behavior impacting on the natural environment that meets the needs of the present without compromising the ability of future stakeholders to meet their own needs	Elliot (2011)
IS for sustainability	IS-enabled organizational and social practices and processes to improve the economic, social, and environmental sustainability of organizations and/or private households	Melville (2010)

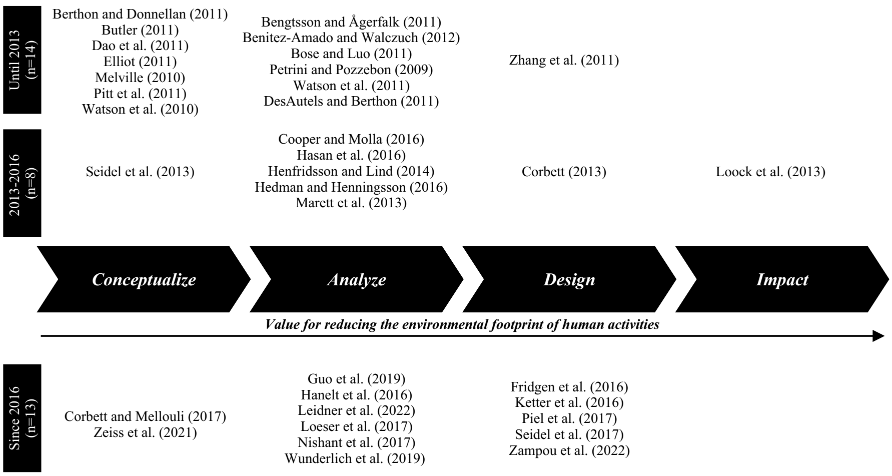

Fig. 2 Literature on environmental sustainability in IS research. Adapted from Malhotra et al. (2013) and Gholami et al. (2016)

of Malhotra et al. (2013) and Gholami et al. (2016). By building on previous IS reviews (e.g., Gholami et al. 2016), we are able to identify advances in IS for sustainability research.

Studies classified in the *conceptualize* domain laid a foundation that spurred future sustainability research, especially for literature in its infancy, such as Green IS/energy informatics (see Fig. 2). Articles in this domain have produced meaningful conceptual frameworks (e.g., Melville 2010; Watson et al. 2010; Butler 2011; Dao et al. 2011) that provided necessary framing for a growing empirical body of research (e.g., Watson et al. 2011; Marett et al. 2013; Seidel et al. 2013, 2017; Hedman and Henningsson 2016; Loeser et al. 2017; Leidner et al. 2022). Additionally, the research identified in the conceptualize value space fosters a shared understanding of fundamental sustainability concepts (e.g., Elliot 2011) and directs focus on emerging areas of interest (e.g., Pitt et al. 2011; Corbett and Mellouli 2017; Zeiss et al. 2021).

Studies in the *analyze* domain predominantly examine the formation of Green IS strategies (e.g., Henfridsson and Lind 2014; Hedman and Henningsson 2016), the supporting role of IS in green initiatives (e.g., Petrini and Pozzebon 2009; Bengtsson and Ågerfalk 2011; Hanelt et al. 2016), how to assimilate knowledge to promote sustainable organizational behavior (e.g., Cooper and Molla 2016; Leidner et al. 2022), and the impact of sustainability practices and strategies on organizational performance (e.g., Benitez-Amado and Walczuch 2012; Loeser et al. 2017; Nishant et al. 2017). Additionally, the research focuses on the drivers (e.g., Watson et al. 2011) and effects (e.g., Guo et al. 2019) of behavior-changing IS in the context of environmental sustainability as well as their adoption by individuals in both private (e.g., Wunderlich et al. 2019) and business (e.g., Marett et al. 2013) settings.

Studies in the *impact* value space remain sparse. The topics of investigation among the design (and impact) studies are highly diverse and involve, for instance, modeling languages to identify the environmental impact of organizational IT systems (e.g., Zhang et al. 2011), benchmarking platforms to promote collective actions of researchers (e.g., Ketter et al. 2016), persuasive systems to induce behavioral changes in individuals (e.g., Loock et al. 2013; Corbett 2013), auction mechanisms for renewable energy projects (e.g., Piel et al. 2017), and organizational sense-making through IS in the context of organizational sustainability transformations (e.g., Seidel et al. 2017).

In the following section, we synthesize insight from these selected publications from the sustainability literature as a foundation for developing a research agenda. We offer contextualized definitions of key terms in Table 2.

3.2 Summary of selected publications

Several studies offer conceptual frameworks for IS environmental sustainability research. At the systems level, Watson et al. (2010, p. 24), introduced the energy informatics framework, which they succinctly summarize as "Energy + Information < Energy," thereby arguing that IS can increase the energy efficiency of demand and supply systems through the use of data. At the organizational level, Loeser et al. (2017) find that the environmental orientation of organizations (i.e., beliefs) positively affects the development of a Green IS strategy, which in turn facilitates the

Table 2 Description of key terms

Concept	Explanation
IT/IS	"An information technology (IT) transmits, processes, or stores information" (Watson et al. 2008, p. 2) "An information system (IS) is an integrated and cooperating set of software using information technologies to support individual, group, organizational, or societal goals" (Watson et al. 2008, p. 2)
Green IT/IS	"Green IT is mainly focused on energy efficiency and equipment utilization" (Watson et al. 2008, p. 2) "Green IS, in contrast, refers to the design and implementation of information systems that contribute to sustainable business processes" (Watson et al. 2008, p. 2)
Green IT/IS practices	"Green IT practices refer to environmental actions implemented in the domain of the IT department while focusing on reducing IT-based environmental impacts; […]" (Loeser et al. 2017, p. 511) "Green IS practices […] cover environmental actions, such as process innovations that use IS to decrease the organization's environmental footprint, or environmental technologies […]" (Loeser et al. 2017, p. 511)
Green IS strategy	A Green IS strategy "describes the fundamental role of Green IS in achieving organization-wide, long-term environmental objectives" (Loeser et al. 2017, p. 512) Further, it "facilitates effective and efficient IT operations and IS-based processes through a resource-efficient IT infrastructure that supports environmental goals" (Loeser et al. 2017, p. 512)
Eco-innovations	"New or modified processes, technologies, practices, systems and products implemented to avoid or reduce environmental harms" (Hanelt et al. 2016, p. 472)

adoption of Green IS and IT practices (i.e., actions) that ultimately lead to organizational benefits. Using an institutional theory lens, Butler (2011) develops a conceptual framework that considers the impact of broader rules and regulations on firm sustainability choices. Specifically, they theorize that organizations require Green IS, such as environmental compliance management systems, to comply with exogenous environmental regulations.

IS researchers developed integrative frameworks that connect sustainability to organizational and individual performance. For example, Dao et al. (2011) leveraged the triple bottom line (Elkington 1997) view of sustainability to develop an integrated sustainability framework. They use the resource-based view to argue that those organizations can develop sustainability capabilities. Specifically, they argue that such capabilities enabled by IT resources in combination with other firm resources enable realizing environmental, societal, and economic goals that lead to sustained competitive advantage. At the individual level, Melville (2010) introduced the Belief-Action-Outcome (BAO) framework to explain why and how individuals' sustainability beliefs lead to actions and outcomes. Taken together, these papers provide rich, integrative frameworks for studying sustainability and IS at the systems, organizational, and individual levels.

Evidence suggests that Green IS/IT practices offer organizational benefits such as enhanced reputation, operational performance, and reduced costs (e.g., Cooper and Molla 2016; Loeser et al. 2017). Moreover, extant literature suggests that Green IS may enable concurrent environmental and economic benefits. For example, the virtualization of organizational IT infrastructures (e.g., desktop virtualization) and business processes (e.g., remote conferencing), results in increased IT agility and energy efficiency (Bose and Luo 2011). Similarly, Hanelt et al. (2016) suggest that physical eco-innovations yield better organizational performance contributions when complemented by supporting IS. They conclude that supporting IS grants firms the technological flexibility to decouple established, unsustainable technologies from physical products and enable using alternative technologies.

When considering plans to introduce sustainable IT, IS researchers have found mixed results on stock market performance. In a study of stock market response to announcements of sustainable IT-enabled products and services, Nishant et al. (2017) observed negative shareholder responses, presumably due to uncertainty regarding actual financial benefits. In contrast, the authors found a positive market response to announcements of specific sustainability initiatives. They report positive abnormal returns and increased share trading volume for announcements about Green IT that support decision-making, potentially due to their ability to deliver immediate economic value.

Several studies suggest that IT can help mitigate the environmental impact of humankind (Watson et al. 2010; Seidel et al. 2013) and enable adaptation to climate change (Hasan et al. 2016). Sustainability initiatives can be hard to launch because they require changes in existing processes, routines, and structures (Bengtsson and Ågerfalk 2011). Evidence highlights the importance of IT executives and their corresponding departments in guiding sustainability transformations (Benitez-Amado and Walczuch 2012). For example, business intelligence systems can be used to establish and monitor environment-related indicators regarding the effectiveness of sustainability practices (Petrini and Pozzebon 2009), thereby bolstering organizations' commitment to sustainability initiatives (Bengtsson and Ågerfalk 2011). In addition to IT executives' beliefs and actions (Benitez-Amado and Walczuch 2012; Loeser et al. 2017), research underscores the role of individuals motivated by personal beliefs in promoting Green IS initiatives (Hedman and Henningsson 2016) alongside organizational sub-communities translating them to executable actions (Henfridsson and Lind 2014).

Within the last decade, several authors have emphasized that tackling more complex issues, such as climate change, will require firms and academics to share knowledge across industries and disciplines on how to construct sustainable IS to enable collective actions (Cooper and Molla 2016; Ketter et al. 2016). Recent research demonstrates that sharing knowledge about sustainable practices between competitors within supply chains may be enabled by interorganizational platforms (Leidner et al. 2022). This intuition has been echoed in Ketter et al.'s (2016) call to action for academe because the issues of sustainability and climate change are likely intractable for a single discipline (Ketter et al. 2016). Hence, they propose a competitive benchmarking platform that allows independent researchers to mutually disclose their theories and design artifacts in a way that their results can be linked across disciplines.

Evidence suggests companies can design systems that encourage people to engage in sustainable behaviors. For example, Energy and Carbon Management Systems, i.e., a type of Green IS "[…] used to calculate, monitor and reduce carbon footprint" (Corbett 2013, p. 340) have been found a powerful tool for promoting sustainable practices in supply chains (Zampou et al. 2022) and convincing employees to adopt environmentally sustainable behaviors (Corbett 2013).

More than providing information, IS research has found that access to sustainability applications and technology encourages individuals to change their behavior. Loock et al. (2013) show that access to a web-based platform that monitored users' electricity consumption influenced their behavior under certain conditions. Real-time feedback about resource consumption induces a behavioral change in individuals (Tiefenbeck et al. 2018).

Beyond individuals' values such as environmental protection, Wunderlich et al. (2019) found that households' adoption of smart meters, i.e., technologies that allow users to monitor and save energy, were driven by demographic, privacy-related, and innovation-related factors. However, Watson et al. (2011) argue that understanding users is not sufficient to effectively address the overarching problem. They advocate that firms aim at building technologically superior systems that anticipate the needs of future customers, thereby moving from simply increasing energy efficiency to designing more effective systems.

Our systematic literature review suggests that environmental sustainability has a strong foothold in the IS discipline, with a steady growth of publications in top journals. Authors have called for more work on topics such as the circular economy, smart cities, and the repurposing of already widely adopted technologies to Green IS. For instance, Zeiss et al. (2021) propose investigating how organizations translate their linear economic activities into circular activities through IS. The authors demonstrate that IS can be used to enable products and components to be reused and waste to be recycled. Further, some argue that IS research should examine sustainable smart cities. In this context, Corbett and Mellouli (2017) develop an integrative conceptual model that links sustainability, political, and administrative spheres, thus enabling sustainable smart cities in line with the 2030 Sustainable Development Goals. Finally, others argue that we must consider how to repurpose existing technologies to meet sustainability goals. For example, smartphones represent an often overlooked opportunity to effectively address climate change (Junglas and Watson 2006; Pitt et al. 2011). Smartphones can be leveraged to monitor energy consumption, persuade users and change their behavior, promote greener lifestyles, or control green smart home devices (Pitt et al. 2011), among other things.

4 Critical issues

While IS for sustainability research has enriched the understanding of individuals' behavior, systems' design, and firms' environmental sustainability choices, there remain many opportunities for advancing the understanding of how the interplay of people and technology contributes to, or undermines, sustainable development (Isensee et al. 2020). As a result, we outline possibilities for actionable research on individuals, technology utilization, digitalization, and inequity. In doing so, we focus on particularly pressing questions, pertinent to not only environmental sustainability but also to economic and social sustainability. To do this, we use the classification which emerged in our literature review in Sect. 3.1 as well as the three pillars of sustainability described in Sect. 2.

4.1 Individuals and environmental sustainability

Substantial attention has to be paid to understanding individuals' choices to engage with IS for sustainability. Within this genre of research, scholars have developed frameworks to explain why individuals use IT to support environmentally sustainable goals. For example, Melville's (2010) BAO framework has been used to frame studies of drivers and constraints on the use of Green-IT. Scholars have applied BAO to study the influence of individual beliefs and actions on sustainability outcomes. For example, Hedman and Henningsson (2016) show that individuals motivated by personal beliefs promote Green IS within organizations and receive top management support if their efforts are aligned with the corporate agenda. Much IS for sustainability research focuses on individuals voluntarily engaging with Green IT and how this leads to green outcomes (e.g., Gholami et al. 2013; Molla et al. 2014). Such work is important because individuals possess many opportunities for engaging in sustainable technology use. For example, existing research explores the adoption and effective use of Green IS to foster energy-efficient behavior in private households (Loock et al. 2013; Wunderlich et al. 2019).

Hence, although many studies have examined drivers that lead individuals to adopt Green IS or pro-environmental IT behaviors, there is a lack of research examining the actual impact (e.g., Loock et al. 2013) of these systems and behaviors (see

Fig. 2). This may be due to studying impact requiring examining more difficult-to-access information on ongoing use, switching behavior, or abandonment. However, having established a baseline understanding, we propose future IS for sustainability researchers to move beyond adoption to connect individuals, their beliefs, and their context to ongoing sustainable IT use:

- Consider, for instance, Green IS such as electricity monitors which are increasingly popular in private homes. An individual may use this type of Green IS in their home to conserve energy through behavioral changes achieved by the persuasiveness of the technology. However, research examining whether such persuasive technologies enable the required long-term behavioral changes that go beyond an initial positive effect is scarce (e.g., Wemyss et al. 2019), especially in the IS domain.
- In addition, there is a dearth of IS research addressing whether behavioral changes through technologies in one domain (e.g., water consumption) spill over into other domains (e.g., electricity consumption). Take, for instance, the study by Tiefenbeck et al. (2013). The authors found that a water campaign unsurprisingly reduced the water consumption of participating individuals. At the same time, however, an increase in electricity consumption was observed in the respective households. Such spillover effects are likely to remain unobserved in the conceptualize, analyze, and design dimensions are shown in Fig. 2, but might come to light in the impact dimension.
- Staying with the above-mentioned example of electricity monitors, it is furthermore crucial to consider the resources used to produce Green IS and the resulting electronic waste, as these costs can undermine any notion of sustainability. The latter is particularly apparent if only short-term behavioral and belief changes are induced by Green IS, such that the net savings enabled by the behavioral change may not compensate for the costs induced by production and disposal. It is therefore notable that, to the best of our knowledge, the so-called rebound effect (e.g., Melville 2010) has been left largely unexamined for the most part in the IS for sustainability literature.
- Moreover, adoption studies often dismiss the fact that IS such as smart home devices themselves consume energy. Therefore, there is a need for studies that go beyond just the adoption of Green IS and sustainable IT behaviors and beliefs towards examining the *impact* on an individual's overall environmental footprint, thereby addressing the lack of impact studies as shown in Fig. 2. Examining the nature and the actual impact of individuals' changing beliefs and behaviors may help identify barriers or facilitators to the prolonged adoption of pro-environmental IT practices.

Moreover, relatively little IS for sustainability research focuses on negative environmental beliefs and attitudes or mandatory use contexts. The latter has gained prominence in recent research due to divergent user responses to mandatory IT introduction (Bhattacherjee et al. 2018). Such work is important because even in mandatory use contexts, users have substantial discretion over their behavior (Seidel et al. 2013) and negative beliefs could substantially change their behavior. Consider

Marett et al. (2013) who found that truck drivers may shirk mandatory Green IS. Specifically, they found that economic benefits, as well as industry pressure, shape truck drivers' intentions to continue using intelligent bypass systems. The authors, therefore, argue that in fostering the adoption of sustainable technologies, greater emphasis needs to be placed on beliefs that shape the understanding of the benefits most relevant to the target group in question.

To shed light on the connection between individuals' technology use and IS for sustainability, future research needs to explore the incentive systems that drive voluntary and mandatory use of Green IT as well as boundary conditions that limit individuals' discretion over when to engage in sustainable behavior. Key questions to consider include:

- How does the interplay of resources and the context for Green IT use shape individuals' willingness to act on sustainability beliefs and realize corresponding goals? Research needs to examine how the availability of technology and resources influences individuals' compliance with Green IT practices in both organizational (Marett et al. 2013) and private (Loock et al. 2013; Wunderlich et al. 2019) contexts. To do so, we believe research will need to examine how to connect environmental sustainability to social sustainability, as it is critical to understand how the broader values in social systems shape how individuals form and enact sustainability goals at home and work. For example, how do broader social goals towards efficiency and money management translate to the decision to become more energy efficient or purchase new technologies? At home? Or at work?
- How does individual discretion across domains for use change the calculus for sustainable IT use and the commitment to such behavior? Research needs to examine the drivers of voluntary and mandatory sustainable IT use in the above-mentioned contexts, namely at work and at home. We do not know if sustainable IT use behaviors at home cross over to the workplace or vice versa. If they do, understanding the drivers of repurposing sustainable IT across domains has profound implications for encouraging sustainability in our broader society (Burleson et al. 2021).
- How do positive and negative beliefs about sustainability change behavior? Given we know that positive beliefs and attitudes (Gholami et al. 2013; Molla et al. 2014) encourage individuals to promote Green IT and Green IS, is it safe to assume that negative beliefs undermine them? It well might be that people do not act on negative beliefs, for fear of sanctions from people around them or a desire to propagate a positive image. Alternately, they may feel pressured to act on positive beliefs, for fear of sanctions for not complying with broader social beliefs about behavior. Further, we do not know if individual-specific or context-specific factors mitigate the impact of positive and negative beliefs on sustainable IT use. For example, even while an individual holds positive beliefs about sustainable IT use, individual dispositions such as resistance to change or the presence of strong habits could result in their not acting on their intentions. Another fruitful avenue in this context could be to investigate how individuals cope with the cognitive dissonance resulting from competing cognitions (i.e., beliefs, attitudes, values)

regarding the sustainable use of technology or the use of Green IS (ElHaffar et al. 2020). In this case, it might be valuable to extend existing or develop new conceptual papers to potentially introduce new theoretical perspectives for the attitude-behavior gap phenomenon.

As evidenced by Loock et al. (2013), the aforementioned themes provide an opportunity to further develop knowledge of the impact dimension (Fig. 2), thereby closing the current gap in the IS literature. We believe advancing our understanding of the interplay between the context, individuals and the technologies themselves will shed light on how to promote Green IS/IT practices in individuals and to build more effective eco-innovations. Insights from this area of questions are aligned with the concepts Green IT/IS practices and eco-innovations with a focus on the societal and economic pillars of sustainability.

4.2 Technology utilization and sustainability

As we study constructing sustainable sociotechnical systems, we acknowledge that there remains much work to be done to understand how to encourage sustainable use of the IT itself and the infrastructure that supports the use of IT.

On the one hand, we recognize that the IS research community has invested substantial attention to understanding how to encourage the consumption and adoption of new information technologies. For example, the vast majority of technology acceptance studies have focused on how utilitarian and hedonic factors drive decisions to use or purchase new technologies (e.g., Wakefield and Whitten 2006; Gerow et al. 2013). Historically, the IS research community has focused on how to encourage adoption and then maximize the value creation of new technologies. On the other hand, we recognize that outside of the IS research community, researchers have leveraged notions from technology adoption to understand sustainable IT use. For example, researchers have drawn on the Technology Acceptance Model to understand how to encourage the adoption of sustainability practices in fields such as construction (Katebi et al. 2022), supply chain management (Anser et al. 2020), and agriculture (Naspetti et al. 2017). Yet, the literature appears to leave the question of how to encourage individuals and firms to engage in the prolonged use of technologies largely unaddressed (Zeiss et al. 2021). In this vein, we believe that there is a need to increase the value realized through the extended use of existing technologies. By doing so, we can address the connection between superficially unrelated topics such as technology innovation and the growth of e-waste. Therefore, with IS field maintenance in mind, further conceptual papers with discipline-native theories must be developed in addition to the above-mentioned need for further impact studies.

Where the current IS for sustainability research directs attention to “make-buy” decisions (e.g., adoption), it does not direct attention to “stay put” decisions (e.g., extend the lifespan) and to wait to upgrade or replace existing systems. Understanding how to change the social ethos to move from “new” to “sustainable” use decisions, will require going beyond focusing on environmental sustainability to also consider social sustainability. Doing so could produce many immediate benefits for sustainable IT use. At the individual level, research that examines how to incentivize mobile phone users to keep existing devices could yield an immediate impact on electronic waste as well as lower demand for scarce resources such as rare earth elements. Lowering the demand for scarce resources might have ripple effects in society such as reducing social impacts associated with the extraction of such resources (e.g., child labor, labor exploitation) or disposal of electronic waste (Barnato 2016). To shift from studying "make-buy" to "stay put" decisions, will require IS sustainability researchers to consider the intersection of how technology can save power (e.g., environmental sustainability) but also how values about innovation and consumption (e.g., social sustainability) address the longevity of technologies and patterns of technology use.

By shifting from studying adoption to continuing use or abandonment, sustainability for IS research creates opportunities for firm-level research on the environmental cost of updating architecture or changing how we manage systems could yield an immediate impact on not only the costs of strategic IT decisions but also the broader externalities of such decisions. To date, such research is scarce in top IS journals and leading conferences. Future work in this area could contribute to the understanding of why firms pursue Green IS strategies and eco-innovations as well as a deeper understanding of the connection between the societal and environmental pillars of sustainability.

4.3 Digitalization and sustainability

In addition to understanding how to encourage sustainable use of existing technologies, we note that the current discourse around digitalization does not effectively address sustainability. We found scant digitization or digital transformation research that directly considers the implications of digitalization for sustainability in top IS journals. Digitalizing processes requires building and sustaining information technologies that functionally must be available 24 h a day, 7 days a week, and 365 days a year. While such systems afford vast opportunities for faster transactions, more effective management of information, and optimizing the speed of moving information, they also consume substantial resources – in terms of power consumption, maintenance, and updating of systems. While we do not question the value of digitalization, we believe it is necessary to more deeply consider how we approach assessing the environmental consequences of digitalization and its implications for the sustainability of sociotechnical systems.

Digitalization research needs to consider the interplay between environmental sustainability and social sustainability, particularly, the unexpected externalities of digital transformation for sociotechnical systems. Consider how digitalizing ride-hailing platforms affected social sustainability. Guo et al. (2019) examined how ride-hailing platforms (e.g., Uber) affect new car purchases. While their findings indicate a decrease in new car purchases and thus more sustainable passenger behavior, competition among different ride-hailing platforms leads to a mitigation of this effect due to the increase in car purchases by drivers and the decline of some existing ride-sharing services (e.g., private taxi services) and may increase the use of other ride-sharing services (e.g., public transportation). In this case, rather than exclusively impacting environmental sustainability, digitalization shifted the costs from one set of actors in a market to another (Diao et al. 2021) and disrupted existing social systems in unexpected ways (Hamari et al. 2016; Frey et al. 2019). More broadly, digital business models may impact shifts in social consumption patterns towards a more sustainable way by designing respective digital business models (Veit et al. 2014).

Considering digitalization's implications for building sustainable sociotechnical systems is particularly important for new, large-scale technologies. Consider blockchain technologies. While research and practice continue to focus on the economic and social benefits of the technology (Rossi et al. 2019), the environmental impact of blockchain applications receives little more than a passing mention in most papers. For example, in outlining the economic and social benefits of blockchain for sustainability, Parmentoal et al. (2022) causally dismiss the environmental impact of blockchain applications for electricity consumption and do not mention electronic waste at all. As IS scholars research and explain the implications of digitization, we must consider the economic, social, and environmental impacts of using technology to transform sociotechnical systems.

On a final note, we believe, that understanding the implications of digitalization for sustainability may require adopting a public goods approach. Consider DesAutels and Berthon (2011), who draw on the tragedy of the commons framework, i.e., the theory that utility-maximizing individuals deplete and benefit from collective resources in the absence of regulated access, while the costs are borne by the commons, to study technology consumption. As notebook prices continue to decline while performance increases, the authors argue that notebook manufacturers are shifting the true costs, i.e., the social and environmental costs, to the commons. However, contrary to their hypothesis that sustainable notebooks should then be associated with increased prices for consumers, they find no price difference between conventionally and sustainably produced notebooks. The authors' explanations include that producers might accept lower margins, that sustainable production is indeed cheaper, or that the true costs are shifted to other, unmonitored parts of the commons. The latter, in particular, might entail serious consequences, as such practices would consequently fail to address the problem in question, but merely shift its impact to other domains. Therefore, talking about sustainability, we need to consider the effects on all three dimensions to recognize such impact shifting. Hence, this aspect touches mainly upon the economic and environmental pillars of sustainability and integrates work that contributes to insights covering the concepts of Green IT/IS and eco-innovations.

5 Summary

We started this opinion piece on IS sustainability research with an illustration of the complexities of defining the term sustainability. Based on extant literature, we have demonstrated that environmental sustainability constitutes just one of the three pillars that need to be considered. In this vein, we have provided definitions for each of the three pillars, as well as for IS for sustainability. We have shown that IS sustainability research focuses mainly on the environmental dimension and that the other dimensions are systematically studied only in conjunction with the environmental pillar, thus leaving room for future studies specifically aimed at social and economic sustainability. Furthermore, we call on future scholars to use the lens of sustainability for the study of social phenomena when appropriate. However, we also point out that in order to use this lens, it is essential to sufficiently define sustainability-related concepts due to prevent ambiguity.

Focusing on IS field maintenance, we have classified the existing IS for sustainability literature and subsequently synthesized selected publications in the field. Building on this, we identified critical issues in the current body of literature and established an agenda for future research. Most notably, we focused on three themes, namely individuals, technology utilization, and digitalization which we then aligned with the potential contributions which can enfold with reference to the three pillars and the classification from Malhotra et al. (2013). First, at the micro level, we direct future research toward negative environmental beliefs and attitudes of individuals and further call for more impact research in this context. Additionally, we emphasize the need to examine different contexts, namely the use of Green IT/IS in voluntary and mandatory as well as business and private settings. Second, we suggest that IS research needs to shift towards promoting sustainable buying and consumption decisions by private customers to enable a circular economy, thereby creating a window of opportunity to address both social as well as environmental sustainability. Lastly, we argue that current IS research oftentimes insufficiently integrates the adverse environmental consequences of technologies such as blockchain into its research as well as negative spillover effects by targeting solely the environmental dimension.

To conclude, we note that IS researchers, given their emphasis on novelty and relevance, have focused considerably on understanding how to promote the adoption of Green IT and Green strategies. In doing so, traditional IS researchers have directed attention to the many different facets of digitalization in the past few years, with our journals and conferences filled with vociferous debates and commentaries on digital transformation, digital platforms, artificial intelligence, etc. At the same time, given our views of ourselves as being socially responsible researchers, a parallel theme of energy informatics and Green IS or IS and sustainability has also grown in prominence. However, as our examples above highlight, given the existential crisis that the world is itself facing, is simply doing research on sustainable IS enough? Or should we also shift our attention to ways in which we can engage in research that focuses not only on the adoption of IT for sustainability but also on practices that encourage the use of IT for a long time, in order to address issues tied to economic and social sustainability? In this piece, we share our views on what needs to be studied next, and help chart a path for future IS for sustainability research such that it not only contributes to the world's current struggles with sustainability but also contributes to building a better world for generations to come.

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Declarations

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Authors and Affiliations

Daniel J. Veit[1] · **Jason B. Thatcher**[2]

Jason B. Thatcher
jason.thatcher@temple.edu

[1] University of Augsburg, Universitaetsstrasse 16, 86159 Augsburg, Germany

[2] Temple University, Speakman 210, 1810 N. 13th Street, Philadelphia, PA 19122, USA