A Literature Review – Sustainability through IT

Seminar paper

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Abstract

Digitalization brings many new potentials that can contribute to sustainability. Information technologies continue to develop and significantly impact the economy and ecology. New strategies must be considered to achieve climate goals, be resource efficient, and act in an environmentally friendly way. Information technology can play a crucial role here, yet it needs to be sufficiently explored in the literature. There are currently many different definitions of information technology about sustainability. In general, sustainability is a multidimensional concept, so there needs to be more understanding of how information technologies can affect it and what fields of application are possible.
This study raises awareness of information technology, especially among those who advance sustainability and understanding, and contributes to both information systems and organizational research. Therefore, this paper aims to deepen the understanding of sustainability through information technologies by conducting a systematic literature review. Using a grounded theory approach, the final analysis of 27 articles identifies capabilities along the dimensions of macro-level, business-level, intelligent logistics, impact, and technology with corresponding subcategories.

Keywords: Green Information System.

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1 Introcution

The environment is deteriorating because of human activity and disturbance, and there is a genuine need to address this problem because it puts at serious risk the basis of human civilization (Bruntland-Comission 1987).

The 28th of July 2022 marks the "earth Overshoot Day" which point out when humanity has used all biological resources that Earth regenerates throughout the year – earlier than ever before. The Global Risk report of 2022 shows that the United Nations Climate Change Conference succeeded in getting 197 countries to align on the Glasgow Climate Pact and other landmark pledges. Still, even these new commitments are expected to miss the 1.5°C goals established in the 2016 Paris Climate Agreement and increase the risks of a disorderly climate transition.Climate change continues to be perceived as the gravest threat to humanity (The Global Risks Report 2022).If humanity wants to continue to survive on earth, we must become more sustainable.During the last decades, sustainability research has emerged as an interdisciplinary research field, and knowledge about achieving sustainable development has grown. Still, sustainability remains an open concept with myriad interpretations and context-specific understanding (Purvis et al. 2019).There are many different and incompatible definitions of sustainability; an inspection of the words and their origins suggests that defining sustainable development is easy. The problem is determining what must be done to achieve sustainable development (Pearce et al. 1994).Souter et al. (2010) proclaim, technology is a key possibility for achieving a long-term balance between human and sustainable development. DeGarmo et al. (2011) argue that sustainability is primarily an information challenge. New dimensions of environmental performance must be integrated into measurement systems to facilitate transparency and allow for responsible decision-making and accountability to internal and external stakeholders.This paper focuses on sustainability through information technology (IT). Prior research revealed that information technology has been making astounding progress and has already influenced many areas of our everyday life. IT can change the behavior of businesses and consumers and can help the environment without sacrificing economic output (Redclift 1992). Information technology's potential environmental benefits and risks have recently attracted scientific research interest. Although many extensive studies on the energy efficiency of IT systems have been conducted in recent years, the impact of IT on the environment still needs to be sufficiently assessed and understood.

On the one hand, the widespread and intensive use of advanced IT applications and services promises significant improvements in many sectors, such as industry, logistics, commerce, healthcare, and education, as well as in society. In addition, IT applications can be used to optimize various processes and thus support new strategies and mechanisms for the sustainable use of natural resources (Aleksic 2014). I tie in with suggestions by contributing new insights to the information technology literature and deriving practical implications. Therefore, I examine recent publications from IS and sustainable development research. The remainder of this paper is structured as follows: First, I describe the methodological approach for the rigorous literature review. Second, I present the findings of the review process, including the categories identified. Finally, I describe the practical implications of my findings, present limitations, and propose directions for future research before I conclude.

2 Background

This paper aims to present the current literature on sustainability through information technology. Therefore, creating a general understanding of the IT definition is essential. There are two areas in IT research. The use of IT causes (as of 2010) 2% of the total Co2 emissions. Therefore, much research focuses on how IT can become more sustainable. For example, considering environmental criteria when purchasing IT equipment and services, the energy-efficient operation of IT in data centers, and environmentally friendly disposal practices. The other part of the research focuses on the remaining 98% of Co2 emissions and how IT can achieve sustainability. This brings a new perspective to the multidimensional nature of the term (Purvis et al. 2019). This paper is based on the definition from Watson et al., who reinterpreted the concept of IT in the context of sustainability. They said, "[...] that this exclusive focus on information technologies is too narrow and should be extended to information systems, which we define as an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals. To the commonly used Green IT expression, we thus prefer the more encompassing Green IS one, as it incorporates a greater variety of possible initiatives to support sustainable business processes. Green IS is inclusive of Green IT." (Watson et al 2010). It is not easy to distinguish between the two terms "green IT" and "green IS". So, I decided to follow the "taxonomy for the subfields of sustainable IS research" developed by Kosshal et al., which shows the aspects of Green in IS and Green by IS. "Green in IS includes the efforts of the IT industry to produce more products and services with using less resources in a more ecologically friendly way, and Green by IS, which encompasses the other industries and their efforts to pursue the new IS enabled opportunities to achieve their economical and ecological goals" As shown in Figure 1 (Kossahl et al. 2012).

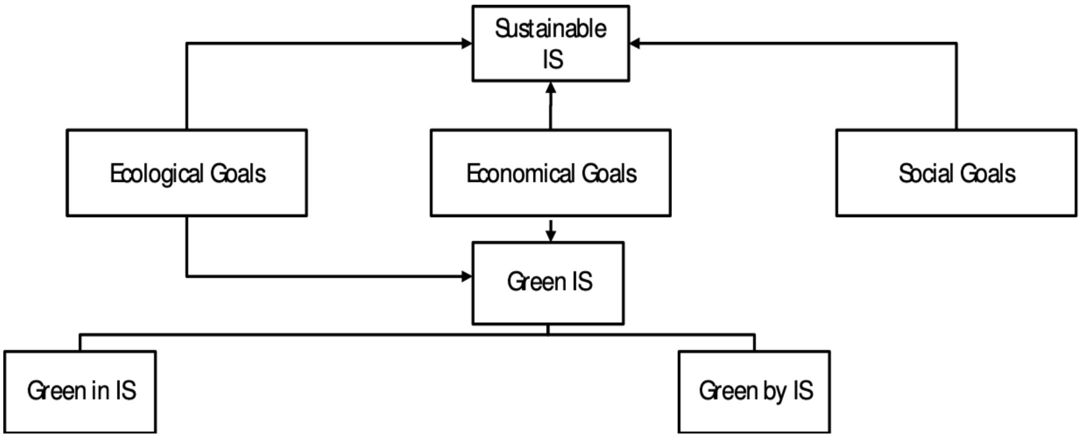

Figure 1 taxonomy for the subfields of sustainable IS research

Information System
Information systems are socio-technical systems that comprise human and machine components, in particular, serve task fulfillment and are used for optimal provision of information, coordination, and communication according to economic criteria (Leimeister 2021).

Sustainability
The most cited definition of sustainability is the Brundtland definition: "Sustainable development Is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Bruntland-Comission 1987). According to Elkington (1998), sustainability can be achieved in institutions by considering three crucial dimensions, namely, social, economic, and environmental. The balancing of environmental protection with economic growth and social progress is usually known as the triple-bottom-line model.

3 Method

This Paper has the aim to create an overview of which aspects were identified as important for sustainability through Information Technology by research in recent years. Therefore, I executed a systematic literature review in which I identified key findings, build dimensions and point out possible approaches for future directions of research. For this project I did a structured literature search process, a selection process as well as a qualitative analysis. These approaches were chosen in order to ensure a holistic and rigorous literature review of high quality. I describe the three approaches are detailed in the following.

Literature Search:
I conduced a systematic literature searching with the underlying structure by Webster and Watson (2002). I followed their approach for a systematically searching literature. I started with the keyword

search by using search terms like “Sustainability” AND “Information System”. Like I explained in the background I deiced to include the search term “Green by IS” to achieve more accurate results.

I deliberately chose to not include similar search terms such as “sustainability AND IT”, “Green IT”, or “Green in IS”, as I intended to find sources that are more referenced the concept of sustainability through Information Systems in total to get the big picture. I finally adjusted the search terms to “Green Information System” to match the topic of this paper. I searched the databases EBSCO, ScienceDirect, AISeL, IEEE Xplore and Google Scholar as well as the top IS journals.

Literature Selection:

Within the literature selection I filtered the initial literature in three steps to select appropriate papers only. First, as I conducted the search in multiple redundant databases, I identified duplicates and removed them afterwards. In total 23 papers had to be removed, which reduced the initial dataset from 89 papers to 66 papers. Second, I checked the papers where I could not directly access the full text. Nevertheless, from my initial search table 19 papers more must have been deleted due to the lack of full-text access. Finally, I examined each paper regarding the relevance for this literature review. I first checked the title and keywords of each paper, before I read each abstract a lastly examined the body of selected papers. To evaluate the relevance of each paper I formulated following exclusion criteria: 1) Not consistent with the scope and purpose of the literature review 2) Not peer-reviewed (Journal or conference) 3) Outdated research 4) Non-commercial context in focus (e.g. education) 5) Certain industry or country in focus. I evaluated each work based on these criteria. In doing so, I ensured that only sources with a substantive relation to the research were processed in the following. Appling this process 31 papers were removed, which reduced the initial dataset to 16 papers. After completing these steps I performed a forward and backward search following the approach of Webster and Watson (2002). Within backward search papers cited by the authors of the literature I initially identified are considered. In the forward search, I searched the databases for articles that cited the literature I had previously found. I reviewed these papers against the exclusion criteria described above to determine whether they should be considered. In this way, five additional papers from the forward search and nine papers from the backward search were added to the research table. After this selection procedure a total of 27 works were compiled from 2011 to 2022, with 80% spread over 2016 to 2022, reflecting the timeliness of this research field. The final data set consists of 26 Articles and one conference proceedings. An overview of the publication outlets and years can be found in the appendix (Appendix 1).

Qualitative Analysis:

To prepare the qualitative analysis I first added additional information to the research table for the selected studies. Therefore, I checked each source and collected information such as purpose, central statements, method, qualitative/quantitative, sample size, Green IS definition and perspective (organization-level/ environmental- level/ sustainable- level). This allowed me to gather a more detailed overview of the data collection. For analyzing the studies, I used the grounded theory recommended by Wolfswinkel et al. (2013). Accordingly, I have divided the analysis into three sequential coding processes. In this way, I was able to identify connections and inconsistencies within the various studies and expand my knowledge of the research subject. First, I applied open coding by conceptualizing any findings from the text that seemed relevant to the review’s research question. I read each paper and generated abstract codes for relevant text excerpts. Second, I performed axial coding, by grouping the codes into categories. In this way relations between different categories within the data set were formed. Third, I proceeded selective coding, by refining the categories from step two and linking them to dimensions. To ensure the traceability of the analysis process, I used the before mentioned research table to collect every code relating to the different studies. Moreover, I have also summarized the codes in a conceptual map to clarify the connections.

4 Results

The final dataset for the analysis includes 27 papers. The reports by Loser et al. 2017 and Santarius et al. 2020 on the impact of information systems on sustainability represent milestones in the research field of information technology. A total of 14 papers in the final sample examined information systems and their impact on sustainability from a higher-level perspective. In comparison, 11 papers focused on the enterprise level and 2 on direct implementation in practice. It is important to note that theoretical constructs that are not directly or uniformly measurable are operationalized. Different observable measures and different understandings of information systems and sustainability from the literature are used. This is intended to provide a complete and multidimensional literature analysis that captures the topic's depth and breadth. The literature confirms that it is increasingly important to understand which aspects to achieve sustainability in the digital environment. During the analysis, I identified the following five relevant dimensions to address the challenges of achieving sustainability through IS:1) Macro-level, 2) Business-level, 3) Intelligent logistics, 4) Impact, and 5) Technology. As I have chosen to conduct a concept-centered literature review, I have visualized an overview of the findings in a concept matrix (Table 1). In the following sections, I will present these dimensions more differentiated way and explain which functions can be assigned to each dimension. For this purpose, I will present the dimensions with their respective subcategories. Within the subcategories, I will also address which functions were highlighted by the researchers, address impact factors, and explain the impact of applying this function.

References	*Year*	Macro-level	Business-level	Intelligent-logistics	*Impact*	*Technology*
Akande et al.	2019	X				
Aleksic	2014	X			X	
Bai and Sarkis	2013		X		X	
Bastida et al.	2019	X			X	
Bayindir et al.	2016	X			X	
Bieser and Hilty	2018	X	X	X	X	
Bokolo et al.	2018	X	X		X	
Chatti	2021		X	X	X	
Chou and Chou	2012		X		X	
Chuang and Huang	2016		X		X	
Frehe and Teuteberg	2015		X	X	X	
Hakpyeong	2021	X			X	X
Hanelt et al	2016	X	X		X	X
Higón et al.	2017	X			X	
Jenkin et al.	2011		X			
Khan and Xiemei	2022	X				
Khan et al.	2020	X			X	
Loeser et al.	2017	X	X	X	X	X
Lund et al.	2017	X			X	
Mageto	2022			X	X	X

Mahdavi and Sojoodi	2021	X			X	
Olawumi and Chan	2022			X		X
Pohl et al.	2019		X		X	
Santarius et al..	2020		X	X	X	X
Sarkis et al.	2013		X	X	X	X
Vidmar et al.	2021		X	X		X
Yang et al.	2018		X	X	X	X

Table 1. Concept matrix

4.1 Macro level

Under the macro level, I define aspects of Green IS research that go beyond purely entrepreneurial thinking. At the macro level, multidimensional approaches to achieving sustainability through Green IS are presented. Heterogeneous systems are considered as a whole and described in more detail below.

Green IS and the ecological Footprint

Green IS on a macro level has the sustainability task of reducing the ecological footprint. The influence of Green IS on the ecological footprint is viewed critically in the literature. Some argue that negative effects arise from growing energy consumption (Khan and Ximei 2022; Khan et al. 2020). Others postulate a positive effect on environmental sustainability through IS technologies (Aleksic 2014; Mahdavi and Sojoodi 2021; Higón et al. 2017; Khan et al. 2020; Bastida et al. 2019). The impact of Green IS on the Ecological Footprint of a country depends on several factors. These are GDP, population and the share of industry in production. Green IS is shown to have an extraordinary impact on reducing energy consumption, reducing CO2 emissions and the resulting damage, and reducing emissions of other pollutants (Mahdavi and Sojoodi 2021).It is also postulated that IS plays an important role in reducing emissions in developed countries, while in developing countries technological progress is not sufficient to reduce emissions through ICT. (Khan et al. 2020; Higón et al. 2017). One of the major challenges will therefore be to support developing countries entering the global IS market and to play a more active role in combating global warming (Higón et al. 2017). It is estimated that 120 million tonnes of Co2 can be saved globally per year. Thus, IS measures that bring about behavioural change and energy efficiency have a significant impact on the energy sector (Bastida et al. 2019).

Smart Citis

Smart sustainable cities is a concept that combines environmental sustainability, urbanisation and technological development. It is a term that combines smart city and sustainable city and describes the use of IS to make cities more sustainable and improve the quality of life (Akande et al. 2019; Bokolo et al. 2018).The use of IS in urban systems and areas includes, among other things, capturing, collecting data.These should help to manage resources and the environment carefully and contribute to their protection. Furthermore, water, soil and air pollution should be reduced and mobility as well as the interactions between society and technology should be demanded (Bokolo et al. 2018). Supporting a city through IS is particularly important as urban populations account for a large share of global greenhouse gas emissions while consuming 70% of the world's resources (Akande et al. 2019).

Smart Grid is also mentioned in this context.

Smart grid means combining the electricity, heat and transport sectors so that flexibility can be increased in these different areas. The smart energy system is based on three grid infrastructures, Smart Electricity Grids, Smart Heat Grids and Smart Gas Grids (Lund et al. 2017).The main focus is on the information system which involves real-time communication, demand-side management, dynamic pricing and distributed generation to provide a secure, energy-efficient and cost-effective electricity supply to consumers through the use of renewable energy sources (Bayindir et al. 2016).

4.2 Business level

In the literature, different strategies are presented to achieve sustainability through information systems in the company. Since sustainability strategies only refer to the company, I have decided to present this business model. It stands out from the macro level, as the company is perceived as a smaller entity. In the business transformation, concrete strategies from the current literature are presented and refer to entrepreneurial action and the integration of networks for sustainability.I will take a more differentiated view from the literature in the following.

Strategies for achieving corporate sustainability through IS

In many studies, the focus for achieving sustainability through IS is on replacing an original, mostly non-digital product system with a digitalized system or on optimizing the system through IS devices. In this sense, IS effects are mainly considered from a technological perspective, namely substitution and optimization (Pohl et al. 2019; Chou and Chou 2012; Chuang and Huang 2016; Hanelt et al. 2016)**.** However, the potential value of Green by IS must be recognized and acknowledged by companies and organizations before Green IS can be introduced to increase the contribution to sustainability (Chou and Chou 2012; Chuang and Huang 2016).

Innovative Green IS a sustainability strategy.

It is often stated that Green IS leads to cost savings and benefits overall resource use and distribution. Innovative digital business models are presented that can use the data automatically provided by users through the IS to help identify excessive resource use and waste (Vidmar et al. 2021, Hanelt et al. 2016). Identifying unrecorded value through waste and resource use data can lead to new value-creation opportunities and improve sustainability. Unrecorded value can be transformed into recorded value faster than new value. For example, data is collected through online business processes and the online presence of products. This data enables continuous business model innovation, iterative solution development, and rapid validation of business viability, saving time and resources. Green IS strategies at the function level can create concrete action plans that improve the company's competitiveness (Vidmar et al. 2021; Loeser et al. 2017). A further starting point of an innovative Green IS strategy is the integration of the customer. In this way, a company can serve the consumer's interest in sustainable consumption by providing sharing information about the origin and characteristics of products. These characteristics can be, for example, the ecological footprint of a product. More information and timely information, as well as better visualization of the information, increase the chances of making informed consumer decisions. This increases the ability of consumers to choose more sustainable ways of satisfying their needs (Santarius et al. 2022).

Digital leader

Another critical role is seen in IT leaders. The organizational Green IS strategy and potential future opportunities and challenges, as well as collaborative cross-functional strategic planning processes, are closely related to the IT leader. The organizational Green IS strategy articulates a shared vision between top management and IT leaders and describes the fundamental role of Green IS in achieving organization-wide, long-term environmental goals (Loeser et al. 2017; Bai and Sarkis 2013). The search for unique and exciting greening and sustainability decisions in Green IS management is expected to increase as sustainability strategies become more prevalent in organizations. Having strategic justification tools for these emerging strategic decision situations is essential for all stakeholders to reap the benefits of green modernization gains (Bai and Sarkis 2013).

Current Green IS strategies

The literature identifies four types of environmental sustainability strategies that are relevant to Green IS research.

1 Greenwashing refers only to the image of the company. An environmental policy is publicly announced. The announced policies and practices are not subsequently implemented (Jenkin et al. 2011).
2 Refers to the efficient use of natural and operational resources to reduce negative environmental impacts and focuses on resource efficiency, waste prevention, and control (Jenkin et al. 2011; Pohl et al. 2019; Chou and Chou 2012; Chuang and Huang 2016; Hanelt et al. 2016)).

3 It Also includes attempting to achieve environmental balance objectives (balancing the company's and society's short- and long-term natural resource needs) (Jenkin et al. 2011; Vidmar et al. 2021, Hanelt et al. 2016).

4 Involves integrating environmental sustainability considerations into all company activities and interactions to halt environmental degradation completely (Jenkin et al. 2011, Loeser et al. 2017). New IS technologies will continue to emerge in the future, and digital transformation will be an ongoing process in every company and society. Digital transformation should be used as an enabler for the transformation of companies towards a Sustainable Green IS Business Model that considers the environmental and social dimensions in addition to the economic ones (Vidmar et al. 2021).

4.3 Intelligent logistics

Another critical point in the Green IS literature is value chain management. This section will summarise essential insights into how Green IS can contribute to sustainability in value chain management.

Green IS in supply chain management

The possible end of resources as an absolute limit to economic growth is a central argument for the digitalization of the supply chain. Digitalization should prevent this absolute limit by increasing resource efficiency. At the same time, it is clear that the application of IS requires resource consumption and must be considered (Santarius et al. 2022).As an efficiency-oriented green innovation, Green IS aims to transform a company's supply chain management to optimize resource use and reduce its environmental footprint (Yang et al. 2021).Digital supply chains allow companies to control the production standards of supply components better. IS can also improve coordination and communication between producers and consumers, making it easier to incorporate consumer preferences into the design, production, and marketing of products (Santarius et al. 2022; Frehe and Teuteberg 2017; Yang et al. 2021).Furthermore, supplier relations, including green supplier selection, development, and management, are part of the green procurement function (Sarkis et al. 2013; Yang et al. 2021).Managing this environmental information flow is an integral part of Green IS. Supply chain environmental management encompasses the flow of materials and information throughout the supply chain and strives to reduce, recycle, reuse and substitute materials (Sarkis et al. 2013; Yang et al. 2021).These may be required through the development and application of mobile technologies for monitoring and collecting environmental and sustainability performance data throughout procurement and supplier management activities (Sarkis et al. 2013).Sharing real-time data to integrate the entire supply chain effectively is essential to supply chain management. The importance of real-time data analysis for decision-making is increasing as disruptions can be predicted, and appropriate planning can be made to avoid total failures (Sarkis et al. 2013; Frehe and Teuteberg 2017; Mageto 2022).In this context, IS has profound implications for organizational operations, management, and strategies, such as project teamwork, customer contact, and partner cooperation, in order to compete and succeed (Yang et al. 2021; Mageto 2022). Logistics service providers are expected to invest in these logistics-based information technologies to meet the needs of their customers. Human-machine interaction is an important trend being explored in logistics as logistics service providers look for an optimal solution to achieve a balance and how automation should be carried out in logistics (Mageto 2022).Investment in Green IS is increasingly trending towards Big Data analytics, drones, digital supply chain twins, electric trucks, autonomous trucks and forklifts, and intelligent warehouses. Businesses are hoping for data-driven decision-making capabilities primarily through Green IS technologies with accurate predictive capabilities. The aim is to improve service levels and the efficiency of logistics operations by reducing costs (Mageto 2022).In this regard, policymakers may have a clear idea of which new technology is suitable to influence environmental sustainability positively (Khan et al. 2020).

4.4 Impact

In this section, I will describe the impact of Green IS. Green IS initiatives can have many positive and negative impacts. To describe the possible impact of Green IS, I will go into more detail on benefits, rebound effect, and induction effect.

Impact

From the Green IS literature, many benefits can be derived that can change a company's sustainability and lead to various organizational benefits, but without clearly identifying the nature of these benefits and their origin in specific measures (Loeser et al. 2017).

Furthermore, most studies describe potential rather than actual positive developments through Green IS on sustainability (Santarius et al. 2022).

Nevertheless, key benefits of Green IS are associated with cost reductions through improved resource efficiency of internal operations, revenue increases through a positive corporate reputation, and technological innovations leading to eco-products that can support competitive differentiation and the creation of new markets. (Loeser et al. 2017; Sarkis et al. 2013; Santarius et al. 2022).

Regarding the potential of Green IS to save energy and resources, several studies suggest that the application of digital devices and programs can increase efficiency in various sectors, including the critical sectors of agriculture, transport, and industrial production. Green IS can thereby contribute to dematerialization, decarbonization, and demobilization. (Santarius et al. 2022; Loeser et al. 2017)

The downside of Green IS is that efficiency gains are often counteracted by adverse environmental effects such as incomplete substitution, rebound effects, and induction effects (Santarius et al. 2022).

Concerning higher-order user-related effects, some studies included types of rebound effects and induction effects in the assessment. The rebound effects can be divided into direct effects related to increased use due to cost and time savings and different user behavior than expected. Studies that considered an induction effect considered an increasing total duration of use of the electronic device under study and the purchase of other electronic devices (Pohl et al. 2019; Santarius et al. 2022).

Theoretical arguments for incomplete substitution and potential rebound and induction effects are valid and supported by anecdotal evidence. These ambiguous facts suggest that the overall impact of Green IS on energy consumption via energy efficiency needs to be clarified. (Santarius et al. 2022; Bieser and Hilty 2018).

4.5 Technology

Technological capabilities have been considered marginally throughout the literature. However, in the following section, I will give an overview of the technological capabilities mentioned in Green IS.

Digital Tools used in Green IS

digital tools have been introduced in construction processes, ranging from the widely known internet of things (Vidmar et al. 2021; Frehe and Teuteberg 2017; Loeser et al. 2017) and AI tools like machine learning or data mining (Santarius et al. 2022; Frehe and Teuteberg 2017). These digital tools are mentioned but have yet to be further defined. The selected literature only says that these techniques exist and are in use. In the literature, is, cloud computing (Olawumi and Chan 2022; Loeser et al. 2017; Sarkis et al. 2013; Frehe and Teuteberg 2017; Aleksic 2014; Santarius et al. 2022) and blockchain technology (Olawumi and Chan 2022; Hakpyeong et al. 2021) are explained.

Blockchain technology is described as an emerging information technology. Blockchain technology in the information sector opens up new opportunities in the P2P trading market. For example, in the energy sector, blockchain technology can provide information about renewable energy producers directly to the consumer. This increases transparency, and the sustainability of the energy source can be verified directly. In addition, the blockchain-based model can guarantee the reliability of the acting persons without a centralized management organization and prevent the increase of related operating costs or the compromise of information security. (Hakpyeong et al. 2021; Olawumi and Chan 2022). Cloud computing uses software and computer services by companies that are available via distributed online systems. Cloud computing could lead to a potential reduction in the global use of data centers and distributed IT systems and energy expenditure. It can also help maximize power consumption efficiency and improve recycling efforts. Cloud computing can help organizations improve their Green IS impact by providing shared and on-demand infrastructure with virtualization capabilities (Sarkis et al. 2013; Aleksic 2014).

5 Discussion

The Discussion section is divided into three subsections. First, I present the limitations of this work that need to be considered when interpreting the results. Second, I present practical implications before concluding with suggestions for future research opportunities.

Limitations:

My literature review comes with some limitations. First, this review is based on a relatively small sample of studies limited to a select number of databases. I have applied the exclusion criteria to ensure the quality and overall consistency of the content. I focused only on high-quality scientific articles from peer-reviewed conference proceedings or journals. I did not include non-commercial contexts or papers with a specific industry or country in focus. While there have been occasional industry focuses, most literature has focused on general effects at the organizational or climate level that are relevant to Green IS. Secondly, I did not include synonymous terms such as "information communication technology" or "green information technology" in the search, which could have provided a broader spectrum of research results. This is because the definitions and delimitations of these terms need to be clarified. Thirdly, in terms of scope, I have searched various comprehensive databases. However, other studies, e.g., those not published in English, were not indexed in the database and, therefore, not included in this review. I also applied advanced search filters to narrow the hits in the databases to titles, abstracts, and keywords, limiting the overall search results. Fourth, access restrictions made it impossible to conduct an additional manual search for recent publications in contextually relevant journals in general management and IS, such as the Journal of MIS and Business Economics.

Practical implications:

This research has important practical implications. These are relevant to understanding information systems in the economy and environment. The five dimensionsI have divided Green Information Systems to contribute to awareness of the potential applications in the digital enterprise.Secondly, it enables organizations to rethink their strategies for developing Green IS strategies and respond more quickly to challenges arising from dynamic market structures. In this context, it could also help restructure the organizational sustainability required to become more climate-friendly. Thirdly, the findings can also help the recruitment and selection processes for the appropriate Green IS strategy. They could also be used to develop appropriate organizational sustainability opportunities from existing capabilities. Finally, companies of all types and sizes and public organizations can use the findings for development purposes.

Future research:

Several research gaps were identified in the review of the literature. In addition to this paper's limitations, I address future research opportunities.

As Santarius et al. 2020 point out that the efficiency gains of Green IS are often counteracted by adverse environmental effects such as incomplete substitution, rebound effects, and induction effects, the overall impact of Green IS on energy consumption and energy efficiency needs to be clarified. The statements date back to 2020 and are still relevant, confirmed by my analysis, where I found articles with different perspectives, definitions, and scopes of the phenomenon. Effects such as the rebound or induction effect often need to be fully considered. Accordingly, future research could help investigate which technological benefit effects are relevant in different contexts. It could be helpful to study policy choices for Green IS and their impact. This would make it possible to transfer the general findings of this study to a more specific level, thus contributing realistic results for practical relevance. In this context, gathering practical insights through experiments in contextual organizations would also be beneficial.This will help to communicate Green IS practices more and explore the resulting organizational benefits in the form of cost reductions, improvement of corporate reputation, and green innovation capabilities will be further explored. This can reduce economic uncertainty associated with large-scale Green IS investments (Loeser et al. 2017). Green IS could connect more and contribute more to sustainability by reducing economic uncertainty. Once the sustainability effects of Green IS are empirically proven, a model should be developed in which the opportunities of Green IS are clearly defined and uniformly measurable. In order to measure the effects uniformly. Finally, the development of Green IS strategies could be a piece of the environmental sustainability puzzle.

6 Conclusion

How can sustainability be achieved through information technology? I have addressed this research question by conducting a systematic literature review in this thesis. Beyond the existing research on sustainability and information technology/systems, I also investigated the economic aspects resulting from Green IS. I derived five dimensions by examining the literature on Green IS with a qualitative analysis. These overarching dimensions are Macro-level, Business-level, intelligent logistics, impact, and Technology. The significant influences of Green IS, and the complex entanglements across all three pillars of sustainability take time to capture. For example, technological progress as a cause of efficiency gains in the IS sector primarily leads to economic growth, the sustainability of which is not necessarily given. Potential growth has to be sustainably regulated by Green IS concepts due to efficiency gains. With this literature review, I contribute to the overall picture of the Green IS research field and add value to both IS research and organizational research. The results are interesting for all those who want to contribute to sustainability through IS systems. On the other hand, companies can use the results to create new sustainability strategies. Furthermore, the organizational orientation can be designed accordingly to implement IS. Together with other work investigating the characteristics or impact of Green IS, a holistic concept could be built. However, it should be kept in mind that Green IS is context and country-dependent. The extent of Green IS in companies depends on a variety of factors and can vary. Therefore, future research could explore the different context-dependent application possibilities according to the criteria associated with Green IS through empirical work.

7 Appendix

Publication Output	
A Holistic Approach Conference	1 (2,7%)
Computer Standards & Interfaces	1 (2,7%)
Environment, Development and Sustainability	1 (2,7%)
Environmental Research Public Health	1 (2,7%)
Environmental Science and Pollution Research	1 (2,7%)
Expert Systems with Applications	1 (2,7%)
Helyion	1 (2,7%)
Information and Organization	1 (2,7%)
Information Systems	2 (5,4%)
Information Systems Frontiers	3 (8,1%)
Journal of Business Ethics	1 (2,7%)
Journal of Cleaner Production	1 (2,7%)
Journal of Science and Technology Policy Management	1 (2,7%)
Management Review	1 (2,7%)
Renewable and Sustainable Energy Reviews	3 (8,1%)
Research Square	1 (2,7%)
Smart Energy and Smart Energy Systems. Energy,	1 (2,7%)
Sustainability	4 (10,8%)
Telematics and Informatics,	1 (2,7%)
	27 (100%)
Year	
2011	1 (2,7%)
2012	1 (2,7%)
2013.	2 (5,4%)
2014	1 (2,7%)
2015	1 (2,7%)
2016	3 (8,1%)
2017	3 (8,1%)
2018	3 (8,1%)
2019	3 (8,1%)
2020	2 (5,4%)
2021	4 (10,8%)

2022	3 (8,1%)
	27(100%)

Appendix 1. Descriptive Data Analysis

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