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Reference Model for Sustainable Information Systems Management: Establishing a Holistic Research Agenda

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Abstract
Green IT has become a well-known topic in academic journals and conferences of the IS research community. Recently, a shift from Green IT to Green IS could be observed. Green IS is a more far-reaching concept that comprises IT-enabled business and production processes as well as human skills and activities such as IT management. To proceed towards a holistic approach of sustainable IS management that addresses all dimensions of the triple bottom line, social aspects should be considered next to environmental issues. To do so, we propose a research agenda in the form of a matrix that reveals possible fields of action where a new triple bottom line thinking has to be integrated into prevalent business practices and decision-making processes. As a first step, we define the core processes of IT management as basis for our reference model: govern, source, make, and deliver. On the basis of the ten suggested fields of action, we identify a wide range of possible sustainability initiatives that allow for a more sustainable IT management in the context of an extensive literature review. The practice-oriented Reference Model for Sustainable Information Systems Management adds to the body of knowledge by consolidating and structuring established concepts. This is helpful for both practitioners and academics: practitioners get an overview of possible measures to make their organizations more sustainable and academics can draw on the classification system to identify and close research gaps in a systematic way.

Keywords: Green IT, Green IS, Reference Model, IT/IS management

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ABSTRACT

Green IT has become a well-known topic in academic journals and conferences of the IS research community. Recently, a shift from Green IT to Green IS could be observed. Green IS is a more far-reaching concept that comprises IT-enabled business and production processes as well as human skills and activities such as IT management. To proceed towards a holistic approach of sustainable IS management that addresses all dimensions of the triple bottom line, social aspects should be considered next to environmental issues. To do so, we propose a research agenda in the form of a matrix that reveals possible fields of action where a new triple bottom line thinking has to be integrated into prevalent business practices and decision-making processes. As a first step, we define the core processes of IT management as basis for our reference model: govern, source, make, and deliver. On the basis of the ten suggested fields of action, we identify a wide range of possible sustainability initiatives that allow for a more sustainable IT management in the context of an extensive literature review. The practice-oriented Reference Model for Sustainable Information Systems Management adds to the body of knowledge by consolidating and structuring established concepts. This is helpful for both practitioners and academics: practitioners get an overview of possible measures to make their organizations more sustainable and academics can draw on the classification system to identify and close research gaps in a systematic way.

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1 INTRODUCTION

The significance of information technology (IT) has been continuously increasing for nearly all businesses. Today, almost every process within a business is in one way or another supported by IT (Zarnekow et al. 2005). This cross-sectoral effect is increased through phenomena such as a steadily growing internationalization and the digitalization of the value chain of businesses (Straube et al. 2009). Combined with increasingly advancing global networks and the resulting strong IT penetration within business processes one can see a

simultaneous growth in the impact and significance that IT has on economics, ecology and society as a whole. In recent years, the public and sciences have discussed the ecological challenges that IT faces, mostly under the term “Green IT”. These challenges are particularly driven by the rising energy consumption of IT systems, the necessary infrastructure to run increasingly complex business applications that require more powerful servers as well as the intensified usage of the Internet (Buchta et al. 2009; GeSi 2009).

In contrast to that, many IT organizations are faced with decreasing IT budgets whilst being confronted with top management’s request to measure and demonstrate the value proposition of IT (Gartner 2010). Insofar, sustainability in information management not only relates to Green IT aspects but also has to account for the potential of information systems (IS) to support sustainable principles within business processes and products (i.e. Green IS). However, most current sustainable activities performed by IT organizations concentrate on isolated and, for the most part, uncoordinated technical (energy-) efficiency parameters with a narrow view on decreasing costs (bottom-up approach). This approach will not suffice in the long run and has to be complemented by a holistic approach with strategic target settings for sustainable management, integrating the various existing perspectives (top-down approach). Concluding, it can be stated that the consideration of sustainable characteristics with the goal to create and implement a sustainable IT management system still represents a great challenge for many organizations. As a result of these considerations it is only logical to raise questions such as what impulses the sustainability approach will have for future research in IS and how this approach can efficiently be implemented. Against this background, this paper aims at deriving a research framework for sustainability within IS. The main focus hereby is the development of a practice-oriented model for sustainable information systems management (SISM) that provides a holistic implementation and control of the sustainability approach in information systems management. Therefore we define the following research questions that this paper will address:

- What is the status quo of sustainability orientation in IT organizations and which requirements for the SISM model can be derived therefrom?
- How can sustainability in information systems management be holistically implemented and which research fields can be identified?

The goal of this paper is to create a structural sustainability framework for research and practice, to identify current deficiencies in the realization behavior of businesses and to determine relevant research topics within the field of sustainability in IS. To achieve these goals, chapter two will define and distinguish the relevant terms and constructs. Following this, the underlying research design and the resulting requirements for the SISM are described in chapter three. Chapter four firstly presents the SISM in its entirety and afterwards analysis the identified research fields and fields of action (FA). Lastly, chapter five concludes the paper and gives an outlook on future research in this field.

2 THEORETICAL BACKGROUND AND RELATED RESEARCH

2.1 Sustainability Management and Sustainable Information Systems Management

Management approaches within the field of sustainability are based on the political-societal driven “triple bottom line” model and follow the assumption that sustainable economic activities need to integrate economical, ecological as well as social aspects (Elkington 1997). Through the simultaneous consideration of all three “bottom lines” of sustainability a holistic sustainability management in companies is achieved, balancing the interests of all internal and external stakeholders, thereby enabling a perpetual continuance of economic activities. Following this line of thought, the following basic understanding of

SISM is used throughout the entire paper: *The SISM model addresses the adequate integration of economical, ecological and social interests into the management of IT organizations with the goal of designing and implementing a sustainable management within the organization.* The purpose of the SISM model therefore is to integrate the concept of corporate sustainability holistically and application-oriented into the management activities of IT organizations, to enhance existing approaches of information systems management towards more sustainability and to introduce demand-oriented management approaches.

2.2 Green IT and Green IS

For several years now the IT industry has labeled its sustainability and resource protection activities with media-friendly terms such as "Green IT" (Molla 2009; Murugesan & Gangadharan 2008), "Green Information Systems (Green IS)" (Watson et a. 2010), "Environmental Sustainability of IT" (Elliot 2010) or "IT-for-Green" (Loos et al. 2011). The sustainability discussion in IT is mainly based on two fundamental viewpoints (Elliot 2011; Loos 2011; Molla 2009): On the one hand IT is being viewed as the object of environmental protection by broaching the issue of the increasing power consumption of running IT infrastructure and consequently the IT induced climate-damaging CO2 emissions (Green IT). On the other hand, especially under terms like "Green-for-IT" or "Green Business", the contribution of IS towards supporting sustainability goals of companies is contemplated and in consequence, it is analyzed in how far the use of innovative IS (e.g. intelligent (real time) control of logistic processes) can reduce the environmental impact in the (core-) processes of said companies (Loos 2011). The latter emphasizes the role of IT as an enabler to handle the sustainability challenges organizations are faced with, which, depending of the industry, can vary greatly (Mingay & Maio 2007).

At the moment the identification of optimization potential to increase energy efficiency of deployed technologies is central to the implementation of Green IT initiatives. Harmon and Auseklis (2010) see cost reduction and performance targets as the main drivers behind Green IT adaption in IT organizations and therefore understand Green IT as "the practice of maximizing the efficient use of computing resources to minimize environmental impact" and confirm that this point of view only represents a partial view of the overall concept of sustainability (Harmon et al. 2010).

Watson et al. (2010) criticize this purely technology-oriented view of Green IT. They prefer the terminology of Green IS and argue that the role of IT as an enabler for sustainable business process within organizations ("IT-for-Green") should represent a central element of the discussion on sustainability in IT. Correspondingly, Elliot (2011) considers both perspectives when defining ecological sustainability in IT as "[…] activities to minimize the negative impacts and maximize the positive impacts of human behavior on the environment through the design, production, application, operation, and disposal of IT and IT-enabled products and services throughout their life cycle" (Elliot et al. 2011). This definition, which integrates Green IT and Green IS, complies with the understanding of SISM in this paper.

2.3 Environmental Impact of IT

The strategic requirements for an IT organization und the provision of IT resources are mainly dependent on what role is ascribed to IT within a company: Is IT seen as a strategic success factor for the differentiation in competition or is IT only a supporter of business processes with the goal to enable more efficient processes (Melville & Kramer 2004)? This fundamental determination of IT's role is strategically significant from a economical as well as from an ecological point of view and establishes the guidelines of an sustainability IT

strategy. The level of IT penetration in business processes of companies, the significance for the core business and the use of IT in end products of a company are amongst the main factors when determining the amount of IT expenditures. Moreover, the significance of IT for the core business also reflects the amount of IT induced CO2 emissions. Consequently, IT is ascribed a higher significance in industries that rely heavily on information (e.g. financial services, media, education, etc.) then, for example, industries that are energy intense (e.g. industrial manufacturing, chemical companies, etc.), in which IT is primarily seen as having a business supporting role (Mingay & Maio 2007). It therefore is not only comprehendible but necessary to differentiate between different types of IT induced environmental impact: The first degree (1st) environmental impact of IT describes the direct negative impacts that are created through the production, deployment and disposal of IT. That includes the resource input for the fabrication of IT hardware, the consumption of electrical energy through the use of IT infrastructure (which has not been generated through renewable resource and/or CO2 neutral) as well as the numerous negative impacts that emerge through electronic waste (Hilty et al. 2006). This constellation of issues is addressed by "Green IT" and includes the operation of data centers (DC), the IT equipment that is being used in the office environment (OE) as well as IT sourcing and disposal. Naturally, industries that can be considered information intense see a high amount of directly IT-related CO2 emissions (figure 1).

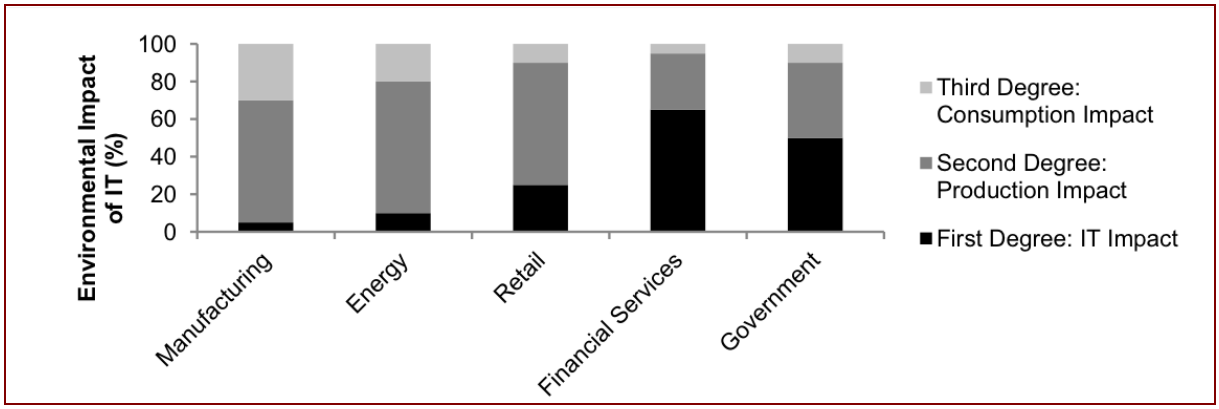

Figure 1: IT related environmental impact for specific industries (Mingay & Maio 2007)

IT related environmental impacts of the second degree (2nd) revolve around the production and business processes within a company and are therefore addressed by "Green IS" or "Green-for-IT" (Loos et al. 2011; Nedbal et al. 2011) Watson et al. 2010). The second degree impact is especially significant for manufacturing industries (see figure1). In contrast to the first degree, second degree impacts have mostly positive repercussions, for example in the form of IT supported efficiency gains in internal processes. Lastly, the third degree (3rd) environmental impact summarizes the impacts that occur in the usage phase of a product and/or a service through the customer. However, this group of impacts is only relevant for companies for which IT represents a part of their end product, e.g. online banking or Smart Homes (Buchta et al. 2009).

3 REFERENCE MODEL FOR SISM

The following model of a sustainable information systems management (SISM) poses as a response to the challenges described above, by ensuring a application-oriented integration of sustainability (economy, ecology and society) to create a foundation for further development of existing and the introduction of new management concepts within information systems management. In analogy to the model of integrated information

management (IIM), there will be a differentiation between three parts of the IT value chain, namely source (IT sourcing), make (IT production) and deliver (IT delivery and communication) and, in accordance with the research framework of Business Engineering, the three operational level strategy (strategic goals), processes (planning tasks) and operational implementation (Zarnekow et al. 2005; Österle & Winter 2003). The sustainable IT governance is superordinate to the IT organization throughout the value chain and represents the fundamental strategic interface to the entire company (see figure 2).

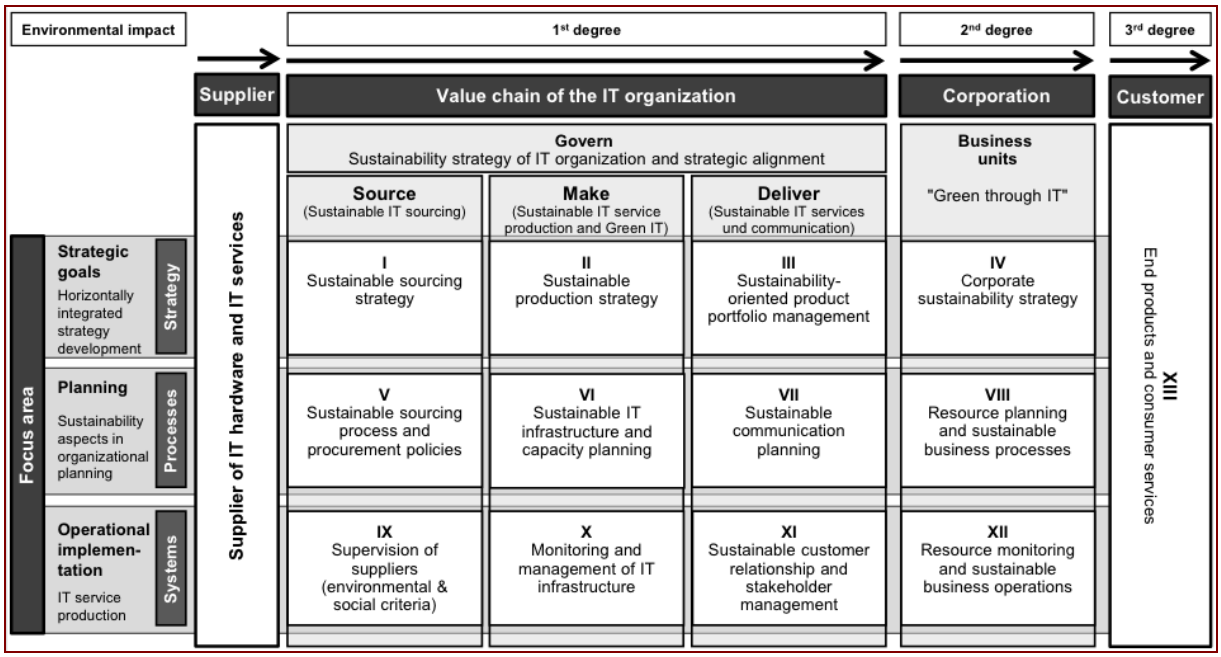

Figure 2: Sustainable information systems management (SISM) model

The SISM model addresses the fields of action that are associated with corporate sustainability within IT organizations, the IT supported business process of a company as well as (in the case that IT is a part thereof) the end products and/or services offered in the market. The matrix structure of the SISM therefore leads to 13 concrete fields of action (FA I-XIII). Through the integration of economical, ecological and social sustainability criteria in each of the FA possibilities to identify, plan and implement sustainability measures on a holistic basis are created, whilst at the same time considering strategic aspects. This is supposed to support IT organizations and researchers to analyze the so far neglected FA of sustainability to create the foundation of a holistic and sustainable information management. The following sections will introduce the central focus areas of the SISM.

3.1 Sustainability in the Value Chain Processes of an IT Organization

Sustainable IT governance represents the interface between a company and the IT organization and is responsible for a consistent, strategic sustainability alignment of the IT organization. In accordance with the definition of the IT Governance Institute (2005), sustainable IT governance has the goal, through guidelines and specifications, to ensure a sustainable management of IT within the organization by defining the surrounding conditions for the subjacent focus areas and value chain of information systems management. This is achieved by identifying and assessing sustainability related risks as well as by accounting for the resource management and the implementation of an effective sustainability controlling.

In the context of the source process, sustainability oriented management of supplier relationships for the procurement of IT products (hardware, software and services), which are needed for the creation of output of an IT organization, is paramount. The sourcing strategy constitutes the foundation for the subjacent levels of the sourcing planning and the operative sourcing management. Furthermore, the in-house production depth of the IT organization is determined, i.e. it is determined which activities should be performed by the IT organization and which activities are to be obtained through external service providers. On the process level (FA V), tangible targets for sustainability criteria of the sourcing process are defined. The sustainable planning of procurement is determined through the specific sustainability requirements in the contract specifications of IT services and serves as a basis for the selection of suppliers. Lastly, on the operational level (FA IX) the actual procurement of sustainable IT products is performed, monitored and assessed with regard to the conditions of the contracts.

The production strategy (FA II) determines the internal activities and the output of the IT production process und therefore defines the framework and the general guidelines of the IT production operations. The main focuses hereby are the utility for the end consumer as well as the efficient completion of the sustainability goals of the IT organization as set by the company. A central aspect within defining the production strategy is the determination of long-term sustainability goals besides establishing the basic parameters of the production infrastructure. New additional influencing factors in this context include the technical and organizational implementation of virtualization and cloud computing or handling the increasing performance density of IT systems. Next to the already established economical and technical requirements there are further issues such as that the components of IT hardware, power supply and distribution and climate control within DC as well as network, printers, storage and workstation systems in OE have to be critically analyzed with regard to the determined sustainability criteria. In the line of production planning (FA VI), especially the increase of energy and resource efficiency in DC and OE promise great potential. In this field explicit production capacities are to be determined whereas the costs of acquisition need to be weighed against the costs of operation in addition to contemplating the environmental soundness of the decision. The necessary resource input should be aligned with the requirements set by the production planning and the ecological goals set by the sustainability strategy. In order to identify optimization potential in DC, particular energy efficiency parameters should be defined. The operational control of the production process (FA X) needs to monitor the effectiveness of the implemented sustainability measures and ensure their efficiency with regard to economic feasibility and the environment alike. The control of the capacity utilization and load distribution in DC in the line of the IT production process are based on continuous monitoring of the energy demand of server systems, network components and cooling, thereby enabling an analysis of the set energy efficiency parameters. The monitoring of the resource demand and the dynamic capacity control facilitate a considerable decrease in energy consumption and operational costs.

Lastly, within the area of the delivery process, business relations between the IT organization and the business units are defined and the distribution of sustainable IT services is controlled. The sustainability demands of the customer (usually internal departments) have to be transformed into technical sustainability requirements for the IT products and services creation. The goal of a sustainable distribution and communication strategy (FA III) therefore is the active configuration and positioning of an IT service portfolio under consideration of sustainability criteria as well as the corresponding embodiment of the marketing mix. The IT organization can choose between an energy and cost efficient strategic orientation, leading to an increase in sustainable services with lower costs, or a differentiation strategy through which the IT services are distinguishable from the competitor’s products because of their pronounced sustainability characteristics whilst the increased production costs can be

compensated through premium prices. Within the area of planning (FA VII), parameters should be defined which on the one hand transform the customer's demands into explicit targets while on the other hand increase the transparency of sustainability aspects within the IT organization's production process. For several reasons the communication of implemented sustainability measures and the reduced CO2 emissions are hereby considered crucial. Firstly, the perception of IT products with distinct sustainability characteristics generates an additional added value for the customer, resulting in the possibility of communicating this commitment to internal and external stakeholders. Secondly, the users of IT services can now have a significant influence on the energy consumption because a sensible and responsible usage of IT resources can have enormous savings in energy consumption as a result. Lastly, in order to fulfill the customer's demand it is necessary to ensure a sustainability-oriented configuration of the IT service portfolio, requiring continuous monitoring and adapting of explicit sustainability criteria and targets of IT activities (FA XI). For instance, this also applies to the integration of sustainability measures in the sustainability report of the company. In addition to that the SISM approach should be an integral part of customer relationship management (CRM).

3.2 Sustainability in the business processes of the company

On the strategic level it is crucial to align the IT strategy and the sustainability strategy of the company (FA IV). The strategy can, depending of the positioning on the market, follow various targets. Bieker (2005) differentiates between efficiency, innovation, transformation and credibility strategies. Efficiency strategies can be supported through the increase in energy efficiency and the reduction of operational IT costs. Through target-oriented investments and the buildup of know-how, possibilities are created that can strengthen the technological innovativeness of the company and at the same time support sustainability-oriented product and service innovations. Companies can be transformed through a fundamental change of the business model and through reengineering of internal processes to address new markets. IT can now create the opportunity, through unusual commitment to the avoidance of emissions as well as to an increase in transparency and the strengthening of external relations, to support a stakeholder-oriented credibility strategy.

The SISM model also addresses the activities of companies on the planning level (FA VIII). The efficiency of every business activity can be improved through the enhancement of ERP systems by sustainability criteria, thereby avoiding excess capacities and increasing the flexible usage of resources, ultimately decreasing negative environmental impacts and reducing costs. The same holds true for a fundamental redevelopment of business processes that can profit from potential automation and support functions by optimally implementing IT. Examples for this are teleconference systems, intelligent building and fleet management systems or material management databases for procurement and recycling.

It is possible to calculate, control and optimize resource usage and emissions through environmental information systems (EIS) (FA XII). Additionally, employee and customer awareness of environmental aspects can be created thereby giving companies that are on the cutting edge of this issues an opportunity to differentiate themselves from their competitors. At this point, it is important to notice that the fields of action IV, VIII and XII address the internal production and business processes.

3.3 Sustainability in End Products and Services of the Company

The fields of action described in chapter 3.1 have already been examined in various studies and a multitude of measures are being implemented within various organizations. The

fields of actions depicted in chapter 3.2, which require a close collaboration between the IT organization and the business divisions, have only been identified and implemented by a minority of companies so far. Even scientific research has only sporadically examined the field of "Green IS" although many researchers ascribe great potential to it. The field of action XIII can even be considered mostly unknown for researcher and practitioners alike, only scarce scientific work (e.g. Mingay & Maio 2007; Hilty et al. 2006) point to the existence of this action and research field. In the authors' view this clearly indicates a research gap, resulting in an incredible range of opportunities for companies, whilst requiring a unique combination of IT know-how as well as the capability to develop and design sustainable products and services. One example of a service reducing the amount of negative environmental impacts through the use of IT is online banking, which reduces CO2 emissions and paper consumption. Smart homes, which can drastically reduce energy usage of personal households through sensors and dynamic lighting and heating are a perfect example of a product that uses IT to decrease its negative environmental impacts. Additional examples are traffic management systems or software for electric cars (for example, the Opel Ampera has a total of 10 million lines of code that ensure the functionality of over 100 computer-operated components).

Table 1: Relevant research matters for the SISM model

1st degree	Govern	▪ Enhancement of established concepts (Green ITIL, sustainability in Cobit, Sustainability IT-BSC) ▪ Development of Green IS strategies ▪ Definition of sustainability KPIs and parameters
	Source	▪ TCO view and life cycle analyses ▪ Ecological footprint of IT components fabrication
	Make	▪ Methodology for the assessment of the carbon footprint of IT services (ecological balance sheet) ▪ Development of measuring concepts for the energy usage of IT resources (DC and OE)
	Deliver	▪ Definition of an IT service catalogue under consideration of sustainability parameters (e.g. definition of "Green service level agreements")
2nd degree		▪ Support of company-wide sustainability targets through IS (strategic Green IS alignment) ▪ Green business process reengineering (Green BPR) and Green business process management ▪ Operational environment information systems (OEIS) ▪ IT supported sustainability transformation
3rd degree		▪ Innovative measures and possibilities to reduce the footprint of products and services of various businesses ▪ Identification of application fields as well as determination and comparison of he potential of sustainable IT in different industries

4 Conclusion

The increasing significance of sustainability aspects in IT organizations, as was shown in this paper, can be ascribed to two main lines of thought: On the one hand there is an increase in the demand for IT resources and rising energy prices for the operation of IT infrastructure, which have the effect that a growing number of measures to reduce operating costs become economically feasible (Green IT). On the other hand there is a recent advance in consumer demand for sustainable (IT) products and therefore, through the intelligent deployment of IT, an incredible opportunity to increase ecological sustainability in business and productions processes as well as in products and services (Green IS).

Despite the existence of first approaches to increase environmental protection and resource efficiency there is a shortage of clear strategies and practices through which an adequate sustainability management for the entire IT value chain can be derived. Many IT organizations start sustainability initiatives on the operational level, however, this is mostly done without consideration for the strategic relevance. A harmonization of these measures with the strategic sustainability goals of the company is crucial in order to achieve said economical, ecological and social targets. For exactly this purpose this paper proposes the SISM model, which is supposed to serve as a basis for the implementation of a holistic sustainability management within IT organizations. The model differentiates between 13 fields of action and is therefore perfectly suited as an analyzing tool for potential sustainability measures along specific value chain phases and organizational levels.

The SISM model represents a holistic structural approach for future research in this subject area and identifies numerous research fields. For applied research this leads to the direct necessity to continuously work on innovative and conclusive (management) approaches and standards for the implementation and support of basic sustainability principles.

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