Sustainability: Are We All Talking About the Same Thing?

State-of-the-Art and Proposals for an Integrative Definition of Sustainability in Information Systems

Friedrich Chasin
Department of Information Systems
University of Muenster, ERCIS
48149 Muenster, Germany
friedrich.chasin@ercis.uni-muenster.de

***Abstract*— Degradation of the natural environment is presently attracting significant attention among the Information Systems (IS) academic community. Consequently, the subject of sustainability continues to gain a foothold in the mainstream of IS research. However, as the body of research grows, the exact meaning of sustainability is increasingly becoming a source of uncertainty. The absence of a clear definition of sustainability in the IS domain poses a challenge for operationalizing the concept and limits the methodological viability of research in the field. By means of a systematic literature review, this paper identifies problems related to diverging or even a complete absence of sustainability definitions in the relevant IS literature. The results reveal what constitutes a sound definition of sustainability as a characteristic of a stakeholder activity and a new perspective for Information Systems research on sustainability, in which an activity becomes a quantum of sustainability analysis. The paper discusses the broader implications for further research.**

***Index Terms* — Sustainability, Information Systems, ICT, Definition, Review.**

I. Introduction

We live in a world in which the contribution of humans to the degradation of the natural environment has become a scientific consensus [1]–[3]. Besides ecological problems, we face unsustainable practices within economic and social environments [4]. Urgent calls for radical ways to address unsustainable development [5], [6] are increasingly being answered from within the field of Information Systems [6]–[9]. Where no or little research had addressed the topic in the IS literature only a few years ago [8], [10], a multiplicity of articles, including those in special IS journal issues on sustainability and in dedicated sustainability conferences, such as this one, are now doing the rounds within the IS community.

As the body of research on sustainability in Information Systems grows, the meaning of the sustainability concept is becoming increasingly opaque [11]. IS research reports on competing and overlapping definitions of sustainability [11]–[13]. Different dimensions of sustainability are observed [6], [9], [14] and the concept is being applied at different analytical levels [4], [7], [15], [16]. Given the lack of clarity on the meaning of the term, numerous studies dedicated to sustainability omit explicit definitions of sustainability, which is of course leads to further vagueness. Consequently, calls to "*adopt methods and research approaches that can support (sustainability) research via a holistic approach*" [15, p.98] are difficult to implement, as their prerequisite - an integrative definition of the sustainability concept - barely exists.

The missing definition of sustainability is arguably one of the main reasons for the excessively slow development of what Malhorta, Melville and Watson call an "impactful research on environmental sustainability" [6]. Accordingly, this paper recognizes a need to systematically analyze the understanding of the sustainability concept itself within the IS domain.

The aim of this study is to address the following question: *How can distinct views on sustainability in the Information Systems literature can be integrated, in order to facilitate a more effective operationalization of the concept*? As the methodological foundation, the paper adopts a structured literature review process [17] and analyzes the representation of sustainability in the IS literature on the basis of a concept matrix, as proposed by Watson and Webster [18].

The main contribution of the paper is twofold. First, it provides a comprehensive overview of articles on sustainability within a representative sample of highly ranked IS journals. Second, it synthesizes the plethora of distinct views on sustainability and proposes a sound definition of sustainability for IS, which allows an effective operationalization of the concept. The results of this process should be valuable for the IS domain, as they provide a basis for constructive scientific discourse on the meaning of the sustainability concept and yield recommendations for further research.

The paper begins by briefly outlining the history of the term *sustainability* within and beyond the Information Systems domain and addresses related work on a definition of sustainability. Next, the literature search process adopted in this study is introduced. The presentation of results is followed by a derivation of an integrative definition of sustainability for the IS domain. The most compelling findings and a synthesized definition are then discussed. The paper concludes with limitations and broader implications for further research.

II. History of the Sustainability Concept and Related Work

The sustainability concept is generally regarded as originating in the forestry literature of the 18th century, where it was referred to as *long-term wood productivity* [19]. In 1804, a German academic by the name of Hartig extended the definition by introducing a wide-ranging "benefit" dimension for future generations, which goes beyond mere productivity [20]. Accordingly, forests must be utilized *"[...] to the greatest possible extent, but still in a way that future generations will have at least as much benefit as the living generation*" [21].

Since then, the sustainability concept has spread to other disciplines [22]. Research within [11]–[13] and beyond Information Systems [22]–[26] reports on the multiplicity of competing and overlapping definitions of sustainability. Interestingly, this is different to the related definition of the sustainable development formulated in 1987 by the Brundtland Commission [27], which is found to be currently the most widely adopted definition in research on sustainability [11], [14], [28]–[32].

Specifically for the Information Systems domain, the concept of sustainability was known and familiar before the Brundtland Commission introduced the concept of sustainable development and spurred the interest of IS researchers in environmental sustainability. In fact, the term entered the Information Systems domain at the latest in 1985, as an important component of competitive advantage. Accordingly, "*a generic (business) strategy does not lead to above-average performance unless it is sustainable vis-a-vis competitors*" [33, p.20]. In the course of an increasing awareness of further dimensions of sustainability, the economic dimension in the research on competitive advantage was extended by social and environmental goals [34]–[36].

As for the present, scientific discourse on the current meaning of sustainability in Information Systems appears to be marginal in comparison to other disciplines [26], [37]–[42]. Although insights from other disciplines are valuable, their relevance to the IS field is limited, as they do not address specifics of the domain in which the development of Information and Communication Technology (ICT) artifacts for sustainability requires the concept to be operationalizable. With the exception of Elliot's work on IT-enabled business transformations for sustainability [11], no other IS study explicitly addresses the uncertainties posed by the meaning of the sustainability concept. The main focus of IS research on sustainability over the last few years was on positioning the discipline with regard to the specific field of sustainability[8], [9] and on providing some initial solutions to environmental problems. Due to the different focus, neither of these research branches comprehensively elaborates on the meaning of the sustainability concept.

Arguably, since the topic of sustainability is relatively new, the need for a systematic review of sustainability definition is only just emerging. Previous work in the area therefore provides the basis for analyzing the prevailing understanding of the sustainability concept in the IS domain.

III. Methodology

A. Literature Review Design

This paper adopts a structured literature review as proposed by Brocke et al. [17]. Following the recommendations of Rowley and Slick [43], the focus of this paper is on high quality articles. Consequently, the search for articles on sustainability was conducted in eight top-ranked peer-reviewed IS journals, according to AIS Senior Scholar's Basket of Journals[1]. The online databases SCOPUS, EBSCHOhost and the AIS Electronic Library were used to search for articles.

Since this work is deliberately concerned with the concept of sustainability, titles, abstracts and keywords from articles available through the databases were searched for the presence of any variations of the word sustainability. To simplify the search string, a wildcard notation "*sustain**" was used as it was supported by all employed databases. The relevance of the intermediate search results to the study was evaluated by reading corresponding abstracts. Articles found to be unrelated to the topic of Information Systems for sustainability were not included in the analysis.

Two special issues on sustainability[2] were identified during the literature review. All articles from the special journal issues were included in the review sample. Furthermore, three dedicated literature reviews on sustainability [6], [8], [15] were identified among the articles found. Their resulting set was compared with the result set in this present work to ensure that none of the relevant articles identified by previous reviews was excluded. It should be also noted that these previous literature reviews on sustainability covered the time period before the year 2003 for the selected journals. Using sustainability as a search word, the reviews unanimously identified the time frame until 2003 to contain no articles on using ICT for addressing problems of unsustainable development. Therefore the review in this present study investigates a more recent time period which extends from January 1st 2003 to January 7th 2014 as the day when the search was conducted. Table 1 shows which database was used to search for articles in which of the eight leading IS journals and the amount of search results before disregarding unrelated articles.

After reading the abstracts, the total of twenty relevant articles was identified. Appendix A contains a table with the title, authors, journal, research topic and the publication year for the articles in the final sample.

It should be noted that this review does not include a multitude of other outlets, including conference proceeding, journals and books. Since the review focuses on leading Information Systems journals and uses sustainability as a search word, not all relevant contributions to the topic of ICT on sustainability are considered. However, it is reasonable to believe that the sample is representative and suitable for

[1] http://aisnet.org/general/custom.asp?page=SeniorScholarBasket

[2] MIS Quarterly, special issue on "*Information Systems and Environmental Sustainability*", 2013 and The Journal of Strategic Information Systems, special issue on " *The Greening of IT*", 2011

TABLE I. SELECTED JOURNALS AND CORRESPONDING SEARCH PLATFORMS

Journal	Abbreviation	Database	Hits
European Journal of Information Systems	EJIS	SCOPUS	9
Information Systems Journal	ISJ	SCOPUS	2
Information Systems Research	ISR	SCOPUS	2
Journal of AIS	JAIS	AISeL, EBSCO	15
Journal of Information Technology	JIT	SCOPUS	3
Journal of MIS	JMIS	SCOPUS	6
Journal of Strategic Information Systems	JSIS	SCOPUS	15
MIS Quarterly	MISQ	AISeL, EBSCO	14
total			**66**

analyzing sustainability in the Information Systems domain and for discussing similarities and differences in the definition, and in the application of the concept in ICT-related research on sustainability.

B. Article Analysis and Concept Matrix Design

In the second step, the identified articles were read completely and analyzed with regard to two aspects. First, a search was conducted for all text passages containing either explicit or implicit definitions of sustainability. The total of 61 identified text passages were documented. Second, articles were analyzed manually for all instances in which any reference object was characterized as sustainable. The resulting 159 instances together with the context in which they were used were documented as well.

Subsequently, due to the multiple facets of the sustainability concept and multitude of reference objects sustainability as a characteristic is applied to, both became a subject for the subsequent categorization. Different aspects of sustainability were grouped together using qualitative coding techniques [44]. Similarly, all different reference objects to which sustainability was applied as a characteristic, were categorized as well. The paper uses a concept matrix [18] to represent the variety of identified sustainability aspects. In the process of reading, identifying relevant aspects of the sustainability concept and categorizing them, the criteria used in the concept matrix were updated continuously.

IV. RESULTS

The analysis of twenty articles from top-ranked Information Systems journals reveals how the sustainability term is defined and applied.

A. Concept Matrix

The concept matrix in Table 2 provides an overview of criteria which can be applied to the concept of sustainability and to the manner in which its definition is presented in the reviewed articles.

Explication of the Definition (1)

For each article in the review sample, the concept matrix provides meta-information on whether they explicitly define the concept of sustainability (explicit). Accordingly, six of twenty articles on sustainability provide a definition of the concept [6], [11], [15], [16], [45], [46]. For example, one article adopts a definition of environmental sustainability from Murugesan in which sustainability is defined as:

"*[…] to contain the minimum amount of hazardous materials, to be energy efficient during their use, and to be disposed or recycled with the minimum effect on the environment and human health*" [45, p.7].

In a similar definition with the focus on minimizing negative impacts on the environment, social and economic dimensions are included:

"*[…] (sustainability can be understood as) efforts to minimize the negative economic, environmental, and social impacts of an activity […], whether by a production company, a service provider, a governmental body, or others*" [15, p.97].

Three dimensions of sustainability are also implied in another definition of environmental sustainability being:

"*[…] a multilayered and complex phenomenon. It relates to environmental, societal, governmental, organizational, regulatory, as well as individual factors*" [46, A1].

In one article, a rather broad definition of sustainability as the "*conservation, deployment, and reuse of resources in responsible ways*" is complemented by an extended version for the organizational context. Accordingly, sustainability is:

"*[…] endeavoring to achieve societal goals within commercial goals in such a way as to optimize social, environmental, and economic dimensions simultaneously—rather than these goals being treated as trade-offs*" [6, p.1265].

The triple bottom line idea [47], being an additional notion for ecological, economic and social dimensions of sustainability, is adopted in another definition where:

"*[…] economic prosperity, environmental stewardship and social responsibility all need to be taken into account, supplementing financial performance measures with ecological and social performance assessments*" [16, p.115].

Finally, a number of similar definitions for sustainability are discussed by Elliot, but without presenting a single integrated version (see [11, pp.206-207]).

In contrast to the explicit definitions of sustainability, another group of reviewed articles [4], [8], [11], [14], [15] substitutes the definition of sustainability with the canonical definition of sustainable development. The World Commission on Environment and Development (WCED), also known as the Brundtland Commission, defines sustainable development as:

"*[…] development that meets the needs of the present without compromising the ability of future generations to meet their needs*" [27, p.25].

TABLE II. RESULTS FROM THE ANALYSIS

	Explication of the Definition (1)			Sustainability Focus (2)			Reference Object (3)				Acting Stakeholder (4)		
Citation	*Explicit*	*Implicit*	*Substituted*	*Economy*	*Ecology*	*Society*	*Stakeholder*	*Activity*	*Enabler*	*Consequence*	*Individuals*	*Individuals in organizations*	*Organizations*
[49]		x		x	x			x	x			x	
[46]	x	x			x		x	x	x	x			x
[7]		x			x			x		x		x	
[50]		x			x		x	x	x	x		x	x
[14]		x	x	x	x	x		x					x
[51]		x			x	x		x			x	x	x
[52]		x			x			x			x	x	x
[9]		x			x		x	x		x	x		x
[8]		x	x	x	x	x		x	x	x	x	x	x
[15]	x	x	x	x	x	x		x	x	x			x
[53]		x		x	x			x	x				x
[54]		x			x			x	x	x	x	x	x
[55]		x		x	x			x		x			x
[4]		x	x	x	x	x	x	x	x				x
[56]		x			x			x	x		x		
[47]	x	x			x			x				x	x
[6]	x	x		x	x	x	x	x	x		x	x	x
[13]		x			x				x	x			x
[16]	x	x		x	x	x		x		x			x
[11]	x	x	x	x	x	x	x	x	x	x	x	x	x
total	6	20	5	10	20	8	6	19	12	11	8	10	17

The reason to introduce the '*substituted*' criterion into the concept matrix is the multiple appearance of this substitution case and its symptomatic relation to the ambiguity of the sustainability concept. Despite the wide adoption, the definition of sustainable development has been heavily criticized [11] and found to be unsuitable as a replacement for the definition of sustainability [12]. Typical wordings used in the reviewed articles where the sustainability definition is substituted are: "*[…] the most widely adopted definition of sustainability is that of the Brundtland commission*" [14, p.64] or "*[…] sustainability is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [8, p.1].

If articles contain information about the attributes of sustainability without including them to the corresponding working definitions of sustainability, they are marked in the concept matrix with the label '*implicit*'. For example, the existence of different dimensions of sustainability is implied in one article, when the authors present their aim of the study as "*[…] to provide mechanisms that explicitly relate social, economic, environmental concerns with the technologies and policies addressing these concerns*" [49, p.81]. In the same vein, each reviewed article contained various implicit aspects of sustainability, which are reflected in further criteria in the concept matrix.

Sustainability Focus (2)

The concept of sustainability is used within the analyzed articles to address three basic dimensions of sustainability: **ecological**, **economic** and **social**. The three-fold view of sustainable development originates in the concept of the '*triple bottom line*' as a source of competitive advantage [47] and is referred to explicitly within the review sample [4], [8], [16]. Accordingly, "*sustainable development takes place within the central interactive zone […] between the economic, the environmental/biological and the social/cultural systems. It is subject to a continual process of trade-offs between these systems. Intuitively, […] development cannot be sustainable if one of these systems is not incorporated*" [56, p.3]. The holistic view on economic, ecological and social aspects is, however, rarely observed in the literature. Articles in the review range from tackling only a single ecological dimension [7], [9], [49], [53], [13], [45], [51], [55], to attributing the same degree of importance to each of them [4].

The **ecological** dimension is integral to all reviewed articles and constitutes the core focus of current IS research on sustainability. Among the addressed ecological problems are reducing the global carbon footprint [7], [14], [48], waste reduction [8], [11], [16] and resource consumption optimization [9], [13], [55].

A number of reviewed articles additionally address the link between ecologically sustainable practices and achieving **economic** goals. Accordingly, solving ecological problems does not necessary mean abandoning economic thinking [9]. Sustainability is therefore viewed not as a constraint to doing business [57], but rather as a condition for reducing costs and increasing productivity [9], generating business value from IT [14], gaining competitive advantage [52] and sustaining overall economic growth [54].

The treatment of the **social** dimension of sustainability in IS appears to be underrepresented in the literature. While many authors call for the inclusion of this social dimension as a part of the holistic view on sustainability [6], [8], [15], [11], only one article in the review sample really achieves this by including working conditions as part of evaluating the sustainability of notebook manufacturing [16].

The abovementioned **ecological**, **economic** and **social** dimensions of sustainability are sometimes referred to with different identifiers. In this context, the terms planet, profit and people are synonyms for the ecological, economic and social dimensions of sustainability respectively [14]. Furthermore, a related concept of the so-called eco-goals [58] is used in the reviewed articles [6], [9], [16]. In simple terms, eco-effectiveness, eco-efficiency and eco-equity goals mean working on the right things, delivering competitively-priced goods and achieving equity between people and generations respectively [9]. While eco-equity can be situated within the social dimension of sustainability, eco-effectiveness and eco-efficiency goals represent links between the economic and ecological dimensions. These goals aim at reduced ecological impact by means of the best possible utilization of available resources (eco-efficiency) and, on the other hand, designing new ecologically neutral, but nonetheless competitive products

and services (eco-effectiveness) [58]. Achieving these goals means working simultaneously on ecological and economic sustainability dimensions.

Figure 1 illustrates the three identified dimensions of sustainability including alternative identifiers for the dimensions, and maps eco-goals to them. The notion of sustainable object[3] is used to signal that sustainability dimensions are necessarily applied to a specific object. Correspondingly, an object can be characterized as sustainable if it incorporates all three dimensions of sustainability.

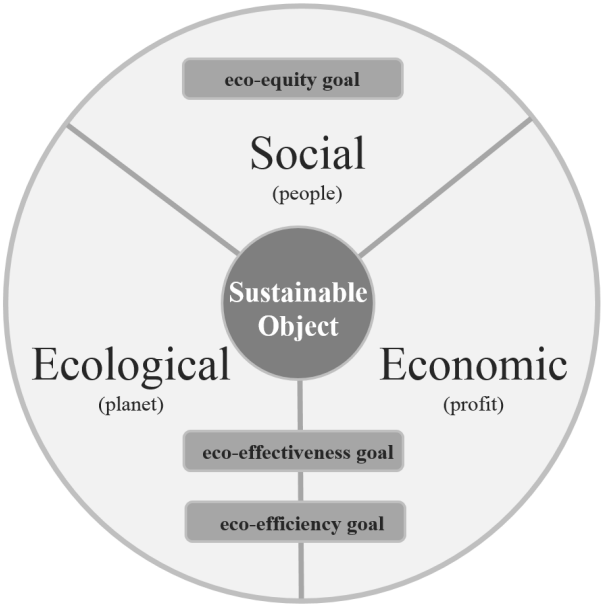

Fig. 1. Three dimensions of a sustainable object

Reference Object (3)

The heterogeneity of reference objects, to which sustainability as a characteristic can be applied, is observed in the reviewed articles. Reference objects on entirely different levels are used to associate sustainable practices. For example, sustainability can be observed on the individual, organizational, process, product or event levels [7] or it can be associated with a production company, a service provider or governmental body [12]. Another suggestion found among the reviewed literature is to distinguish between individuals, groups, firms and communities as objects for sustainability analysis [4] or between sustainable businesses, living and products [16]. Furthermore, ICT artifacts which allow sustainable practices are repeatedly called sustainable. [7]–[9], [11].

As can be seen, the different views as to which objects can be characterized as sustainable are heterogeneous and are therefore only partly compatible. To tackle the problem of heterogeneity, this paper categorizes all occurrences from the review sample in which sustainability is used as a characteristic of an object. Occurrences are identified by searching the articles and then documenting them with the context in which they are found. The subsequent categorization, based on qualitative coding, reveals four categories of objects with which sustainability can be associated. Figure 2 illustrates the resulting categories including the objects comprising them.

The **Stakeholder** category comprises all stakeholders that can act in a manner that allows sustainable development. A sustainable individual, for example, can perform sustainable activities in private households [55] or in any other physical system [51]. An object from the **enabler** category implies that it can be called sustainable, because it allows a stakeholder to act sustainably. As mentioned, ICT artifacts are typical enablers [7]–[9], [11]. A 'sustainable' goal [14] or a 'sustainable' initiative [48] can also foster sustainable organizational processes and individual behaviors and are therefore enablers too. Sustainable activities lead to **consequences** which can correspondingly be called sustainable. Therefore, a notebook, which is produced in a sustainable way, that is, taking ecological, economic and social considerations into account, is called sustainable [16].

A closer examination of categories reveals the fundamental role of sustainable **activities**. Objects in the categories of stakeholders, enablers and consequences can be referred to as sustainable only if they are associated with an **activity** that is sustainable. Another reason to consider activities as a nexus of all possible objects that can be characterized as sustainable are their time dimension. The latter is inherent to sustainability as a concept, which aims to achieve a balance between the present and the future.

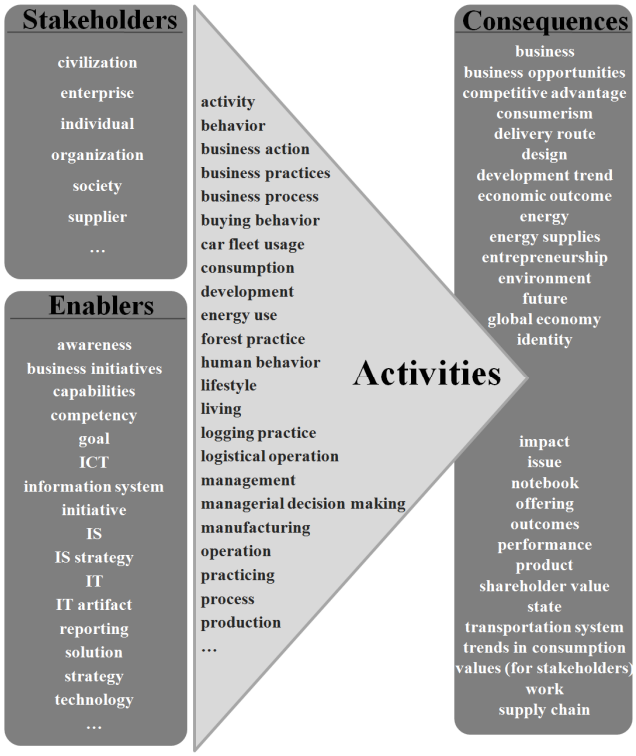

Fig. 2. Four categories of identified reference objects

[3] Note that objects are used here in a broad context. Everything is considered as an object, irrespective of whether it is a physical object, concept or idea

Acting Stakeholder (4)

The reviewed articles reveal different acting stakeholders in the focus of Information Systems research when it comes to sustainable activities. An acting stakeholder in this context is a stakeholder who performs sustainable activities. The articles address individual energy-efficient behavior [55], the behavior of drivers in trucking organizations [48], and the use of carbon management systems by employees to support sustainable behavior [7]. Sustainable organizational processes of are addressed through an analysis of factors influencing the design and manufacture of environmentally sustainable products [45], an analysis of the association between IS and sustainable organizational performance [15] and an assessment of firms' potential to implement sustainable initiatives [54].

Beside articles with a focus on activities of a specific stakeholder, there are positioning articles which theorize on ways information systems can enable sustainable activities in general. In such articles, both individuals and organizations are identified as potential acting stakeholders [6], [8], [9], [11], [46], [49], [51], [53].

B. Synthesis of an Integrative Sustainability Definition for IS

The derivation of an integrative definition of sustainability is based on the insights gained from the preceding analysis of the leading IS literature and is consistent with the identified characteristics of the sustainability concept. The definition aims at integrating compatible aspects of how the concept of sustainability is defined in Information Systems research. The proposed definition of sustainability is therefore derived from and inspired by this literature review. All propositions which were already elaborated in this work are summarized in Tab. 3.

TABLE III. REQUIREMENTS FOR AN INTEGRATIVE SUSTAINABILITY DEFINITION FOR THE IS DOMAIN

#	Proposition
1	Missing or fragmented definitions of sustainability are the source for limited methodological viability of IS research on sustainability
2	Most representational aspects of sustainability are complementary rather than conflicting and can be therefore integrated
3	Definition of sustainability cannot be replaced by the definition of sustainable development
4	Among different objects, to which sustainability as a characteristic is applied, activities have the central importance and must therefore constitute the focus of IS research on sustainability
5	Process, behavior and stakeholder concepts are potential linking elements between the concept of sustainability and the existing body of IS research
6	Due to its wide adoption, the definition of sustainable development must be the inspirational source for a sustainability definition

By addressing these propositions, the following definition of sustainability for the Information Systems domain is proposed:

> ***Sustainability*** *is a characteristic of a stakeholder activity (organizational process or individual behavior) which impacts on natural and social environments and meets the (economic) needs of the present, without compromising the ability of future stakeholders to meet their needs.*

V. DISCUSSION, FUTURE RESEARCH NEEDS AND IMPLICATIONS

The results of this study show that, due to the growing body of research on sustainability within the IS domain, the inadequately defined sustainability concept itself is becoming a source of uncertainty. Fragmented (or even totally absent) definitions of sustainability are conspicuous in the IS literature that specifically addresses the sustainability topic. It is striking that more than a half of reviewed articles provide no explicit definitions of sustainability or substitute it by the definition of sustainable development.

When looking at those sustainability dimensions which form the focus of the reviewed articles, it is clear that ecological concerns dominate the IS literature on sustainability. However, the economic and social dimensions of sustainability are found to be complementary or even synergetic to the ecological dimension. Therefore, the paper encourages a holistic view on sustainability, which requires an increasing emphasis on how economic and social goals can be combined effectively with the ecological goals.

The analysis of different object types to which sustainability is applied in the reviewed literature reveal a multiplicity of problematic applications of the sustainability characteristic. In this context, all different reference objects that are characterized as sustainable are found to be dependent on the underlying sustainable activities. In some cases, actions are attributed to stakeholders and the latter are then called sustainable. Alternatively, actions are enabled by other objects and the enabling objects are then called sustainable. Finally, sustainable actions lead to consequences which are then called, again, sustainable. Therefore, it is evident that, in the first place, sustainability is a characteristic of an activity. Focusing on other objects potentially shifts attention away from activities as the actual drivers of sustainable development.

It is striking, though not surprising, given the history of the domain, that IS research focuses on the sustainability of individual and corporate activities. Although the activities of further stakeholders such as industries, alliances and government have a potential impact on sustainability in general [11], IS research on sustainability in the leading journals provides little information on their potential for implementing sustainable actions. Furthermore, the majority of reviewed articles, with few exceptions, give surprisingly less guidance on which stakeholders can implement which processes or behaviors. Instead, the IS literature tends to theorize on the spectrum of possible actions instead of proposing concrete actions [6].

All in all, the identified challenges create a situation in which uncertainties with regard to the meaning of sustainability are constraining IS research endeavors. An operationalization of the sustainability concept remains difficult, due to a) the lack of discourse on the explicit meaning of the concept, b) unclear scope of the sustainability concept, c) problematic application of sustainability as a characteristic to all kinds of objects and d) uncertainties regarding whose actions must be addressed in order to achieve greater sustainability. The proposed definition of sustainability derived from the IS literature addresses these

issues in the following manner. First, the definition reduces the multiplicity of objects to which sustainability can be applied by describing sustainability as a fundamental characteristic of an activity. Second, it facilitates a more effective sustainability analysis by considering activity as being assigned to a specific stakeholder. Third, it sets the scope of sustainability by adopting a holistic view on sustainability, including ecological, economic and social dimensions. Fourth, by focusing on the sustainability of stakeholder activities such as organizational processes and individual behaviors, it enables the integration of sustainability (as topic) into existing research in the IS domain. Finally, the definition draws on the widely adopted definition of sustainable development by emphasizing the balance between the present and future needs of stakeholders. Overall, the proposed definition promotes a specific perspective on sustainability in the IS field, where a stakeholder activity becomes the quantum of sustainability analysis and more sustainable entities are developed through the composition of single sustainable activities. The implications of this perspective are synthesized into a framework in Tab. 4, which indicates the most relevant future research needs.

TABLE IV. FRAMEWORK FOR RESEARCH NEEDS

	Implications and Recommendations for Future Research
Sustainability Focus	• Adopt a holistic view of sustainability which combines ecological (e.g. impact on natural environment), economic (e.g. competitiveness of sustainable practices) and social (e.g. working conditions) dimensions of sustainability. • State explicitly which dimensions of sustainability are focused on in a particular study and outline directions for addressing the less focused dimensions. • Investigate synergies between ecological, economic and social dimensions of sustainable activities. • Conduct interdisciplinary research in order to address all sustainability dimensions equally.
Reference Object	• Pay attention to which objects the sustainability characteristic is applied. • Focus on sustainable activities, as they are fundamental to addressing sustainability issues. • Identify and address sustainable activities in the background when another object is intended to be described as sustainable.
Integration into IS	• Identify branches of IS with a focus on organizational processes and individual behaviors which are suitable to incorporate the view on activity as a quantum of sustainability analysis • Embed sustainability into the body of IS research through including the sustainability aspect into well-established research topics such as business processes management.
Sustainability Definition	• Evaluate existing definitions of sustainability, including the one proposed in this paper with regard to the aims of the study in question. • Contrast between definitions of sustainability and of sustainable development. • Provide an explicit working definition of sustainability in studies that address this issue and integrate all implicit aspects of sustainability into a definition used for the research project.

VI. CONCLUSIONS AND LIMITATIONS

This paper has analyzed the state-of-the-art with regard to understanding of the sustainability concept in the IS academic domain. To provide data about how sustainability is defined in the literature, a structured review [17] of eight highly ranked IS journals was conducted. Twenty identified articles were evaluated on the basis of Watson and Webster's concept matrix [18]. The findings in this present work reveal shortcomings in terms of how sustainability is defined and applied in the IS literature. In particular, the majority of reviewed articles fail to provide explicit definitions of sustainability and focus on ecological challenges, therefore neglecting the social and the economic dimensions of sustainability. They use sustainability as a characteristic with regard to a plethora of different object types, therefore limiting an accurate and meaningful interpretation of the concept. In a nutshell, the concept of sustainability is found to be a source of uncertainty in the IS research on sustainability.

This paper addresses the above problem by proposing an integrative definition of sustainability for the Information Systems domain and providing recommendations for further research. With the aim of laying a foundation for a better operationalization of the sustainability concept, this work is a call to consider sustainability as a ***characteristic of a stakeholder activity (organizational process or individual behavior), which impacts on natural and social environments and meets the (economic) needs of the present without compromising the ability of future stakeholders to meet their needs***. The central implication of this definition is a compelling need to analyze ecological, economic and social sustainability dimensions at the activity level of a stakeholder.

The study contributes to research in the field in several ways. First, it provides an overview of the articles on sustainability in the leading IS journals. Second, it synthesizes fragmented aspects of sustainability identified in the articles into an integrative definition of sustainability. Third, it provides critical implications and guidance for research on sustainability, which aim at a more effective operationalization of sustainability concept when it comes to developing ICT artifacts for sustainability.

Of course, this study has several limitations. The literature review presented in this work included only eight highly ranked journals. Although it is reasonable to believe that articles in the leading IS journals are fairly representative of the domain, the inclusion of other outlets such as other journals, conference proceedings and books could usefully extend the findings of this work. Furthermore, insights from other disciplines on the concept of sustainability would be valuable, in order to determine whether the proposed definition of sustainability contradicts findings from other domains. Finally, this study does not explicitly elaborate on the link between the proposed definition of sustainability to particular IS branches. Although the proposed perspective on sustainability for IS research is inherently connected with the domain as it is inspired and derived from the relevant literature, the analysis of implications for specific IS branches such as business process management would be most enlightening. Therefore, an application of the definition within both the existing and future body of research on sustainability has a potential to uncover gaps and provide the basis for a more impactful research on Information Systems and more specifically on Information and Communication Technologies for sustainability.

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VII. Appendix A: Articles Identified By The Literature Review

Journal *	Citation	Authors	Title	Research Topic	Year
MISQ	[49]	Marett, Otondo, Taylor	Assessing the Effects of Benefits and Institutional Influences on the Continued Use of Environmentally Munificent Bypass Systems in Long-Haul Trucking	Identification of influences including the environmental benefits on continued use of bypass systems	2013
	[56]	Loock, Staake, Thiesse	Motivating Energy-Efficient Behavior with Green IS: An Investigation of Goal Setting and the Role of Defaults	Role of Information Systems in stimulating energy-efficient behavior in private households	2013
	[47]	Seidel, Recker, Vom Brocke	Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations	Identification of important functional affordances originating in Information Systems, which are required in environmental sustainability transformations	2013
	[6]	Malhotra et al.	Spurring Impactful Research on Information Systems for Environmental Sustainability	Agenda for IS research on environmental sustainability	2013
	[11]	Elliot	Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation	Development of an integrative framework for IT-enabled business transformation for spurring environmental sustainability	2011
	[9]	Watson, Boudreau, Chen	Information systems and environmentally sustainable development: energy informatics and new directions for the IS community	Agenda for IS research on environmental sustainability. Establishment of the energy informatics IS subfield	2010
	[8]	Melville	Information systems innovation for environmental sustainability	Agenda for IS research on innovations for environmental sustainability	2010
ISJ	[51]	Heng, De Moor	From Habermas's communicative theory to practice on the internet	Development of a tool for collaborative authoring to support work of the Global Research Network on Sustainable Development (GRNSD)	2003
JSIS	[46]	Butler	Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS	Development of a model to explain how green IS can support organizational sense-making	2011
	[50]	Zhang, Liu, Li	Designing IT systems according to environmental settings: A strategic analysis framework	Evaluation of environmental impact of IT systems. Extension of the GRL modeling language to enable modeling of rationality behind IT system design including environmental considerations	2011
	[14]	Dao, Langella, Carbo	From green to sustainability: Information Technology and an integrated sustainability framework	Development of a resource-based sustainability framework to enable creating of sustainability capabilities by firms	2011
	[52]	Watson et al.	Green projects: An information drives analysis of four cases	Identification of forces behind successful green technologies	2011
	[15]	Bengtsson, Ågerfalk	Information technology as a change actant in sustainability innovation: Insights from Uppsala	Analysis of effects and implications of sustainable IT-enabled initiatives	2011
	[54]	Pitt et al.	Integrating the smartphone into a sound environmental information systems strategy: Principles, practices and a research agenda	Role of smartphones in shaping environmentally sound strategies	2011
	[55]	Bose, Luo	Integrative framework for assessing firms' potential to undertake Green IT initiatives via virtualization – A theoretical perspective	Identification of factors determining the assessment of a firm's to become green through implementing IT-enabled virtualization	2011
	[4]	Petrini, Pozzebon	Managing sustainability with the support of business intelligence: Integrating socio-environmental indicators and organisational context	Influence of business intelligence systems on the management of sustainability	2009
	[13]	Berthon, Donnellan	The Greening of IT: Paradox or promise?	Agenda for green IT research	2011
	[16]	DesAutels, Berthon	The PC (polluting computer): Forever a tragedy of the commons?	Exploration of the market price of sustainable notebooks	2011
JAIS	[7]	Corbett	Designing and Using Carbon Management Systems to Promote Ecologically Responsible Behaviors	Design of carbon management systems for taking influence on employees towards more ecologically responsible behaviors	2013
EJIS	[53]	Benitez-Amado, Walczuch	Information technology, the organizational capability of proactive corporate environmental strategy and firm performance: a resource-based analysis	Connection between decision making of IT executives and shaping environmental sustainability	2012

* **MISQ**: Management Information Systems Quarterly; **ISJ**: Information Systems Journal; **JSIS**: Journal of Strategic Information Systems; **JAIS**: Journal of the Association for Information Systems; **EJIS**: European Journal of Information Systems