A Review of Subjective Values and Their Implications for Green IS Research

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Abstract

Green Information Systems (IS) are defined in terms of certain sustainability-related characteristics. Sustainability itself is a concept based on subjective values and value judgments, which are political, value-laden, and context-dependent. However, Green IS literature does not provide a sufficient understanding of such subjective values nor their treatment. Also, value-judgments for Green IS have hardly been considered. We adapt material value-ethics to expose the fundamentals of subjective values. Reviewing and synthesizing work in which subjective values and value judgments have been explicitly considered in sustainability decision-making, we improve our understanding of their use and formalization. Finally, we discuss our findings through the lens of material-value ethics, and offer reflective arguments towards clarifying the role of values in Green IS. The paper contributes to a deeper understanding of subjective values and subjective value judgments for sustainability, along with their critical and significant implications for Green IS research.

Keywords: subjective values, sustainability, decision-making, Green IS, material value-ethics

Introduction

Sustainability and sustainable development have received considerable attention from both multidisciplinary types of research (e.g., Hardin (1968), Norström et al. (2014)), as well as practices (e.g., United Nations (2015). A common and accepted understanding of sustainability comes from the United Nations (1987): "to ensure that it (sic. development) meets the needs of the present without compromising the ability of future generations to meet their own needs."

Given the growing importance of information systems in our global world, several authors have called for a greater research focus on information systems for sustainability from a multitude of perspectives, ranging from energy use to sustainable business processes (Malhotra et al. 2013; Boudreau et al. 2008). Seidel et al. (2013) investigate how information systems can support sustainable business practices and participatory decision-making in the context of sustainability transformations, through sense-making affordances such as indicators, novel methods of communications, and multidimensional analysis. Furthermore, information systems are also found to provide sustainable practicing affordances such as

limiting unnecessary output and by making some work location-independent (Seidel et al. 2013). Marett et al. (2013) investigate the main drivers behind the use of bypass systems for the trucking industry and find that financial and normative pressures play a large role while suggesting future research on the factors that can affect market competitiveness. Similarly, the effects of default and goal-setting functionalities in a web-based feedback system on energy consumption show that information systems could have a positive impact on cost-effective customer engagement on a large-scale (Loock et al. 2013). Nonetheless, Malhotra et al. (2013) conclude that the opportunities for information-driven sustainability transformations remain, to a large extent, untouched. Gholami et al. (2016) point out the use of information systems to improve assessments, make better decisions, and for evaluating the efficiency of various initiatives. Also, Gholami et al. (2016) and Elliot (2011) recognize the need for transdisciplinary research to tackle sustainability problems. As such, Green IS should position itself as a problem driven and solution oriented area of research, rather than one developing theories (Gholami et al. 2016). However, the design of information systems for enhancing sustainable practices would all be based on decisions affected by subjective values (Constantinides et al. 2012). Those would implicitly incorporate a variety of trade-offs between outcomes, and therefore it is important that they are made as transparent as possible to stakeholders as well as target users of those systems.

Watson et al. (2010) call for a Green IS initiative to improve poor environmental practices and conduct more impactful Green IS research. One of the key aspects is to "enable and motivate economic and behaviorally driven solutions" (Watson et al. 2010:24). This demands a set of value judgments on the design and use of such a system. Watson et al. (2010) acknowledge self-interest as a frequent driver, which may not work in favor of creating a sustainable civilization in the long term. Melville (2010) mentions several critical factors that are essentially value-based, such as the relevance to practice, choice of metrics, and belief formation, among others. However, even though the notion of personal belief is frequently mentioned in Melville (2010), there is little clarification and understanding regarding how it should be incorporated, measured, or at all represented. Moreover, the question remains as to what specific set of beliefs and values we should incorporate and choose for proposing a Green IS solution that can be impactful in addressing environmental problems.

To investigate the current state of how subjective values have been treated in research on Green IS for environmental sustainability, we followed Gholami et al. (2016) and searched the AIS senior basket of eight journals. To keep a relatively broad initial focus, we searched for: "value judgment" OR "value judgments" OR "subjective value" OR "subjective values." None of the hits were explicitly related to Green IS, and few were related to systems design (c.f., Córdoba 2009) and information systems research in general (c.f., Constantinides 2012). Obviously, the research on Green IS for environmental sustainability has not yet developed sufficient understanding of subjective values and how to incorporate the values in the research. Additionally, the treatment of subjective values important for Green IS has hardly been considered.

Gholami et al. (2016) advocate that we must take a solution-focused Green IS research for solving environmental problems and leverage the transformative power of Green IS for making IS research impactful. The search process of a Green IS solution is in general a complicated decision making process for sustainability (Simon 1996). This decision making process is influenced by the choices and value judgements of the IS researchers who engage in Green IS research, by the subjective values and choices of the stakeholders, and community and society that the Green IS solution is in support of solving sustainability problems.

Due to the lack of Green IS literature on the understanding of subjective values and taken together with the calls for the explicit incorporation of the values in the research, we are taking a transdisciplinary approach in-line with Elliot (2011) and Gholami et al. (2016) to search literature in related research areas. Therefore, we adapt material value-ethics (Kelly 2011) to interpret subjective values. We improve our understanding through reviewing and synthesizing literature which has incorporated subjective values and subjective value judgment in sustainability decision-making: how these values are measured, formalized, evaluated and incorporated in sustainability decision-making? Secondly, we collect our findings and discuss them through the lens of material value-ethics to conduct impactful Green IS research. We offer reflective arguments based on a typology of Green IS as suggested by Ijad et al. (2010). The paper contributes to a deeper understanding of subjective values and subjective value judgments for sustainability, along with their critical and significant implications for Green IS research.

Related Research

Sustainability and Greenness in Green IS

Since the 1987 report of the Brundtland Commission, sustainable development has been a common theme in policy-making circles (Redclift 2005). It consists of economic, social, and environmental dimensions. The report underlines, among other things, the importance of population size and growth to be "in harmony with the changing productive potential of the ecosystem" (United Nations 1987). Redclift (2005) points out the many different uses of the term sustainable development, such as to justify corporate actions and to promote international equality between nations. Hence, the meaning of sustainable development is dependent both on context and culture.

A systems perspective on sustainability was brought forward in the seminal "The tragedy of the commons" by Hardin (1968), who notices the problem of incommensurable goods, e.g., the amount of good fishing brings for one person is incomparable to the amount of good playing computer games brings to another. To Hardin (1968:2), the solution lies in an "acceptable theory of weighting," however intellectually challenging that would be. Furthermore, Hardin (1968) suggests mutual coercion (i.e., coercion agreed to by the majority) as a suitable social arrangement to minimize the use of limited resources independent of individual conscience. The first edition of the book "Limits to Growth," based on findings using the World3 computer model, was published in 1972 (Meadows et al. 2004). The World3 model specifically addresses exponential growth and the limitations of scarce natural resources from a systems perspective and is thus in-line with Hardin (1968).

Redclift (2005) points to the role played by subjective value judgments in sustainability research. Even for natural science research, it holds that subjectivity plays a significant role in determining the research projects, the boundaries, and subsequent taxonomies and categories that might follow. Sustainability research should combine economic, social, and physical science and focus on the linkages between natural and human systems (United Nations 1992). Implementations of normative systems, however, should be carried out by governments in cooperation with businesses and industry (United Nations 1992).

According to the AIS Special Interest Group on Green IS, the information systems discipline can play a role in creating an environmentally sustainable society (SIGGreen 2018). But, as of yet there is no clear and agreed upon definition of Green IS. According to Ijab et al. (2010), some authors view Green IS as information systems that enhance business processes by making them more efficient and less wasteful, and thus reducing the impact they may otherwise have had on the environment. Others see Green IS as information systems that can support organizations, as well as individuals, to make less environmentally impactful choices (Ijab et al. 2010). For example, Boudreau et al. (2008) define Green IS as "the design and implementation of information systems that contribute to sustainable business processes," while Watson et al. (2010) call for a Green IS initiative to improve poor environmental practices. What sets the two apart is, to a large extent, the primary beneficiary of the impact of Green IS. Self-interest has been acknowledged as a frequent driver, which may not work in favor of creating a sustainable civilization in the long term (Watson et al. 2010). One of the key aspects of Green IS is to "enable and motivate economic and behaviorally driven solutions" (Watson et al. 2010). Doing so, however, demands a set of value judgments on the design of such a system. Analogous to that, Ijab et al. (2010) conclude that the "Greenness of IS can be seen as an inscription and enactment of Green intentions and actions, together referred here as Green values, in IS."

Ijab et al. (2010) propose a set of Green IS typologies based on different combinations of *spirit*, *practice*, and *impact*. Spirit refers to a set of properties embedded in the technology, based on the intents and values of the designers of the system (DeSanctis et al. 1994). Hence, the spirit will emerge as an expression of supported values, thru the structure and functionality of the artifact (Ijab et al. 2010). Practice refers to the actual use of, or interaction with, the system (Ijab et al. 2010). Consequently, the practice stems from an interaction with a structure which emerged from the design and development phase, and that is relatively context dependent. Impact is something that is unintended and that emerges as a consequence of the practice, for example, by "shaping beliefs about the environment" (Ijab et al. 2010). The Green impact of an IS would thus have to be discovered thru a post-use evaluation. According to Ijab et al. (2010) it is sufficient for an IS to conform to at least one of the previous terms in order to be Green. Regardless of the precise definition, however, several factors that are essentially value-based, such

as the relevance to practice, choice of metrics, and belief formation, among others, are important for information systems research on environmental sustainability (Melville 2010). However, even though the notion of personal belief is frequently mentioned in Melville (2010), there is little about how it should be incorporated, measured or at all represented. Moreover, the question remains as to what specific set of beliefs we should be willing to try to form.

Sustainability Decision-Making

Green IS exists both *a priori* and *post hoc* to sustainability decision-making. A decision, in its most simple sense, is a choice between alternatives available to an individual, a group or an organization. Decision science concerns rational decision-making, based on consistent arguments and formal methods, to either optimize, satisfice, or to select the best available alternative. It is common to represent decision problems as lotteries with probabilities attached to outcomes (Watson et al. 1978), but sustainability decision problems are wicked and naturally include more than one objective.

Wicked problems are complicated, and the outlook for complete solutions is rather bleak due to, for example, conflicting views, incomplete or contradicting information, and interdependencies on other problems (Rittel et al. 1974). They stem from social pluralism by way of complex interactions involving stakeholder values, multilevel governance, scientific uncertainty (Head et al. 2015). Adaptive management, rather than the use of robust evaluation frameworks, can support policymakers in continuously learning about and evaluating complex issues. However, such a view does not rule out sound reasoning about facts and values. Creating a shared understanding and meaning of a wicked problem is a pragmatic step toward coherent action (Head et al. 2015).

Sustainability decision-making involves problems that are both complex and wicked. Therefore, sustainability decisions are unique and quite hard to formulate, and multiple objectives need to be considered. Often there is no single correct answer. Moreover, there might be no way of knowing even what constitutes a good solution to a sustainability problem, such as an environmental problem. In a sustainability decision-making process, decision-makers face difficulties and challenges when defining a sustainability problem, as well as while assessing and examining the context surrounding it. Consequently, complications can arise when decision-makers frame a particular choice or establish a specific objective to be considered in a particular choice context and identify appropriate alternatives without stakeholder involvement. These complications significantly influence sustainability decisions and the consequences of these decisions. Given those complex challenges, studying Green IS is one way towards managing and resolving sustainability problems.

Subjective Value

Whether value is objective or subjective is disputed in axiology (the academic study of values). Additionally, there seems to be no universal agreement of what is meant by objective and subjective in different contexts. Nevertheless, we acknowledge the discussion about whether values should be considered as wholly objective or completely subjective entities (see, e.g., Lee [1940]). We take the adjective "subjective," in the term "subjective values," to imply values whose appearance to some extent is dependent on the human mind.

Understanding in a cogent manner what subjective values are, requires a meaningful description of our intuitive reflection upon the meanings of various value concepts (Kelly 2011). Material value-ethics, based upon phenomenological analysis, strives to offer a systematic means to reason about values.

Values are phenomenological objects, "present to the mind in feeling," and generally realized through purposeful action (Kelly 2011:10). They are not created by the mind, but their existence is conditional upon human thought and action, and therefore their content must somehow exist *a priori* (Kelly 2011). In analogy with colors, which cannot be fully appreciated without sight, values cannot be appreciated without perception and emotions (Kelly 2011). Furthermore, their relative worth, based on a person's “primal feelings” for them, can only be justified by repeated actions of preference (Kelly 2011). However, Kelly (2011:27) stresses that "Values are not to be confused with the *enjoyment* of a thing that satisfies our needs and desires." The following example provides a clarification: "The values are what we enjoy in the process of sating our hunger, but they are not identical with the visceral satisfaction of the food they produce in us" (Kelly 2011:28).

The understanding of subjective value from the thoughts of material value-ethics stands in stark contrast to a value-theoretical perspective in which "values issue from needs," and a thing is considered to have value, independent of the mind if "it facilitates our needs and appropriate wants" (Rescher 2017:5).

In IS research there is an area called value-sensitive design, in which subjective values have been represented by properties or measures such as privacy, the level of freedom, informed consent, and trust (see, e.g., Friedman et al. [2008]). Essentially, such values should support our well-being and the quality of human lives (van der Hoven 2009) and are thus more in-line with a value-theoretical definition as laid out in Rescher (2017). Moreover, in value-sensitive-design, Friedman et al. (2008) define value to be "what a person or group of people consider important in life" and this supports the dependence of values on cultural contexts. Interestingly, some of these values are defined in terms of other values, as if values are of different orders. For example, Friedman et al. (2000) consider informed consent a value, whereas Millett et al. (2001) base it on the concepts of disclosure, comprehension, voluntariness, competence, and agreement. Haki et al. (2019) emphasize in-use-values, as opposed to exchange-values, in a value co-creation context, and deem something to have value when it is useful to a customer. Chan (2000) suggests that the value of IT investments should span a broad spectrum of values, e.g., profitability, customer impacts, and employee satisfaction, but provides no explanation about the essence of values per se. In Green IS, vom Brocke et al. (2013) attribute some level of "social value" to things that solve societal problems.

From a broader perspective, the interpretation of the concept of subjective value differs greatly between authors. Stirling (1999) argues that subjective values arise from the aggregation of performance measurements of incommensurable factors, be they economic, social or environmental. What determines the choice between incommensurable alternatives is a subjective value system (Spangenberg 2005). According to Gallopin (1996), subjective values are indicators given a special significance, such as targets, reference value, standards, etc. Straton (2006) considers subjective value as a property emerging from a complex system involving both physical necessities such as food and shelter, as well as psychological phenomena such as perception, influences, and expectations. All of these parts effect how humans experience, and express value, and are strongly related to the notions of quality and capacity. In decision-theoretical terms, according to Baron (2000), "value" is a function from the set of outcomes to a set of utilities.

Human values are subjective and prescriptive, and refer to value orientations pertaining to quality of life, as distinguished from economic values which refer to a more objective, descriptive, and shared conception of how the world works and its capabilities in supporting a certain quality of life (van Egmond et al. 2011). Values in the context of sustainability have been defined to be of various types, such as conditions of a system (Braat 1991), prescriptive values (van Egmond et al. 2011), aggregations of incommensurable values (Gallopin 1996; Stirling 1999), and as emergent properties of complex systems (Straton 2006). According to Braat (1991), a subjective value represents a system condition "assumed necessary to achieve sustained development." As an example, Braat (1991) gives "a desired per capita expendable income." The purpose of subjective values is, in the context of Braat (1991), to create a predictive meaning of sustainability indicators.

What constitutes a more or less sustainable action is likely an unsolvable problem (Redclift 2005). That is partly due to the uncertainty about future outcomes but also because the valuation of those outcomes is subjective, and is likely to vary between individual decision-makers as well as between societies and generations. Furthermore, individual choices are not independent and can limit the choice of others due to the scarcity of natural resources (Redclift 2005). Furthermore, exactly what it is that should be sustained remains an open question (Redclift 2005), which naturally cannot be answered objectively. Because decision problems often involve multiple and varying values, of which stakeholders only can make sense of there and then, Norton (2015) argues that sustainability decision-making should be context-dependent, rather than relying on overarching policies.

Methods

To improve our understanding of the explicit use of subjective values we performed a systematic search for relevant literature according to Okoli (2015), followed by a subsequent thematic analysis of the search results according to Braun et al. (2006). A systematic approach was deemed justified even after a

consideration of the critique against such methods by Boell et al. (2015) due to the specific nature of the research question.

Literature Search

The literature search was performed using three different search interfaces: (1) EBSCOhost, (2) Scopus, and (3) Web of Science. The search was performed in several steps, starting with a focus on sustainability, then with the addition of decision-making, and finally with the addition of value judgments and subjective values (see Table 1 for the number of hits in each database for each step of the search process).

Search terms	EBSCOhost	Scopus	Web of Science
(*sustainability* OR *sustainable*)	2,647,390	467,826	526,669
AND *decision-making*	71,710	23,208	18,480
AND (*value judgment* OR *value judgments*	86	29	27
OR *subjective value* OR *subjective values*)	104	33	34
Limiters			
Peer-reviewed	48	33	34
English language	43	31	32

Table 1. Search procedure

During the search, the alternate spellings "judgement" and "judgements" were included as well, but omitted from the table for typographical reasons. Once the results were imported into the reference manager Mendeley, they were aggregated into one set of results. That naturally included a removal of duplicates arising from the aggregation (see Table 2 and 3).

Mendeley	EBSCOhost	Scopus	Web of Science
Import	43	31	32
Duplicate removal	34	31	32

Table 2. Import of results into the Mendeley reference manager

Aggregation of the results from the three searches naturally included the removal of duplicate results (i.e., papers found in more than one of the databases). The inclusion criteria were that the paper should consider value judgments or subjective values explicitly, and involve sustainability decision-making. The first scan for inclusion was based on reading the title and abstract, and by that judging whether or not the article fulfilled the inclusion criteria. When the abstract was deemed to give insufficient information about the content of the article, the full article was skimmed to see if it fulfilled the inclusion criteria. After this first round, 40 articles remained (see Table 3 for the number of remaining articles after each step). The second round of checking the articles for inclusion was done in conjunction with reading the full paper for the purpose of data extraction. Some of the articles were excluded during the analysis process due to lack of relevant content, i.e., too little information to contribute to the analysis.

Action	Result
Aggregation	58
Inclusion 1	40
Inclusion 2	21

Table 3. Aggregation of the search results from the three search engines and checking for inclusion criteria

Analysis of the Literature

We used a theoretical thematic analysis (Braun et al. 2006) within an essentialist/realist framework, driven by the following three questions:

1. How was the concept of value judgment or subjective value defined?
2. How were subjective values measured or judged?
3. How were subjective values formalized or operationalized?

The data analysis was carried out as follows:

1. The articles were printed on paper.
2. Each printed article was read, and the passages that corresponded to either of the three questions were highlighted with the following colors: blue for problem or context, yellow for definitions, green for uses, orange for formalizations, and purple for contributions or enhancements. During this process, we scanned the articles for inclusion a second time, resulting in a further reduction of articles (see Table 3).
3. The highlighted passages were copied from the digital versions of the articles into a spreadsheet.
4. Each piece of extracted data was coded, and the codes, together with the corresponding reference, were printed on paper and cut such that we had one small piece of paper for each code. The codes from the data corresponding to definitions were kept separate from the codes from the data corresponding to formalizations, etc.
5. Each set of codes were then arranged into the themes presented in the Results section. We did two iterations together for each set of codes to fine tune the themes.

We defined themes to represent sets of data that would yield meaningful answers to the three sub questions (Braun et al. 2006) on which the data extraction was based. The aim was to thematize the content such that we could provide a subsequent overview of the articles that would answer the research question. Hence, we identified research results and issues at the semantic level (Braun et al. 2006).

Literature Review: Understanding Subjective Values

What is Subjective Value?

The themes related to definitions of subjective value were: emergent property, manifestations, embedded in the mind of the subject, and grounded in theoretical beliefs.

Subjective values or value judgments (i.e., judgments based on subjective values) are referred to as many different things. Some authors argue that subjective values are embedded in the mind of the decision maker in the form of intuition (Hahn 2015). Stefanovic (2015) notes that subjective value can be something subconscious, and that value judgments often are implicit. Another way of looking at subjective values is that they (whatever they are) eventually become manifested in statements about preference (Nordström et al. 2013), or the intensity of preferences (Estévez et al. 2018). Similarly, subjective values can be encoded in models and consequently impact choice (MacGillivray et al. 2015), or become part of a decision-making tool (Lynch et al. 2010). A third view is that subjective value judgments are based on a set of moral standards or emerge from different theoretical beliefs (Stefanovic 2015) and that they form the basis of normative statements (Walz et al. 1996). Lastly, subjective value is considered an emergent property at a societal or individual level. Scrase et al. (2002) argue that subjective values take the form of a complex chain of policies, rules, or institutions, and that they are constructed in processes of negotiation and conflict. At the individual level, it emerges from expertise, values, and opinions (Nadafianshahamabadi et al. 2017), or a rich combination of discursive practices and practical reasoning under a participatory regime (MacGillivray et al. 2015).

Uses for Subjective Value Judgments

The overarching themes including the various uses for subjective values were: choice of objectives, modeling, and value elicitation.

In the analyzed set of articles, subjective value foremost impacts the choice of objectives, problem modeling, and the subsequent value elicitation. Subjective values are fundamental to the objectives set to be achieved (Nordström et al. 2013), how the fulfillment of those will be measured (Estévez et al. 2018), and selecting a way for ordering their importance (Nordström et al. 2013). When modeling a decision problem there are a multitude of factors for which subjective values play a significant role, such as the definition of the problem (Stefanovic 2015), the time horizon under consideration, the choice of

alternatives and evaluation criteria (Nadafianshahamabadi et al. 2017), and the selection of indicators (de Olde et al. 2016). Furthermore, subjective judgments will underlie the choice of indicator measurements (Hahn 2015), and scoring systems (Stefanovic 2015) and scales for value elicitation (Nadafianshahamabadi et al. 2017). The final evaluation will depend on the choice of weighting schemes (Nadafianshahamabadi et al. 2017), and methods for aggregating values (de Olde et al. 2016). Also, many other things that further constrain the decision-makers' or the stakeholders' choice are brought to the table. Those include discount rates (Nadafianshahamabadi et al. 2017), veto thresholds (Domingues et al. 2015), sustainable levels of production (de Olde et al. 2016), and to what degree vagueness is accounted for (Promentilla et al. 2014).

Elicitation statements are either involving preferences (Grubert 2017; Hahn 2015; Nordström et al. 2013; Walz et al. 1996), criteria weights (Domingues et al. 2015; de Olde et al. 2016; Shamshiry et al. 2015) or scores of various kinds. The latter includes the judgment of quality (MacGillivray et al. 2015), assessment and valuation of the importance of pollution levels (Walz et al. 1996), and the scoring of projects (Lynch et al. 2010).

During the decision analysis process, one needs to be wary about definitions and interpretations of, for example, risks since those possibly emerge from conflicting theoretical beliefs (Stefanovic 2015), and intangible measures of sustainability such as air quality (Nadafianshahamabadi et al. 2017). Furthermore, aspects other than environmental ones, including technical, social, and economic aspects, should be considered when performing decision analysis (Walz et al. 1996). Basic assumptions (de Olde et al. 2016), and previous value judgments (Scrase et al. 2002) can impact choice as well.

Formalization of Subjective Values

The various kinds of formalizations of subjective value were divided into three themes: input, methods, and output.

Formalizations of subjective value judgments are either input, as part of a model (MacGillivray et al. 2015) or as data subsequently fed to the model, or output from various kinds of numerical methods. Numerical input come in many different forms and includes responses to questions with Likert-type scales (Hahn 2015), the result of surveys (Walz et al. 1996), pairwise comparisons (Grubert 2017; Shamshiry et al. 2015), direct rating scores (Nordström et al. 2013), and valuation of improvement according to the SWING-weighting method (Estévez et al. 2018). Input on a linguistic scale is subsequently converted to fuzzy numbers in (Promentilla et al. 2014), and ordinal input converted to levels of utility (Hahn 2015).

The output is commonly in the form of criteria weights (Domingues et al. 2015; Hahn 2015; Lynch et al. 2010; Nordström et al. 2013; Shamshiry et al. 2015; Singh et al. 2016; Stefanovic 2015). Domingues (2015) takes vagueness into account by producing a space of weight vectors. Similarly, Estévez (2018) specifically considers the output to be estimates of the true weights (only present in the mind of the person providing the input). In one study the output takes the shape of aggregated preferences (Estévez et al. 2018).

Several methods are used to convert input values of various sorts to criteria weights and preferences. Estévez et al. (2018) uses the SWING weighting method for weight elicitation. Nordström et al. (2013) applies the SMART method, Shamshiry et al. (2015), Singh et al. (2016), and Grubert (2017) use the analytic hierarchy process (AHP), and Promentilla et al. (2014) use the fuzzy analytic network process (FANP). The aggregation of weight elicitations is sometimes done using the geometric mean, as in (Promentilla et al. 2014).

Discussion

Subjective values in sustainability decision-making are seen primarily as something emerging from expertise, personal values or opinions, and manifested as preferences or as input to models. Hence, the display of values is close to the proposal of material value-ethics from a philosophical standpoint, but little attention is given to the material content of those values, and their interaction with decision-makers' primal feelings. Also, sustainable values are, by definition, good values because they relate to both the thriving and flourishing of humankind, as suggested by value-theory (Rescher 2017).

Discovered thru the act of feeling, and subconsciously embedded in the mind of the decision-maker, values are inaccessible even to the decision-maker themselves. Only as something grounded in moral or theoretical belief, or manifested in repeated deliberate action, can they possibly be predicted, or checked for *a priori* and *post hoc* consistency, given some value-content.

This review supports Martin's (2015) argument for incorporating subjective value judgments in sustainability decision-making, and that these values are important and beneficial. But there are issues and gaps in the research that need to be addressed. First, the representation of subjective values is oversimplified. Some amount of simplification is necessary to be able to reason formally about decision problems (Howard 2007). However, resorting to numbers too early in the process eliminates much of the available information a stakeholder could otherwise provide. Second, stakeholder subjective value judgments are applied in the evaluation of already present alternatives, but not explicitly used to inform the generation of alternatives earlier in the decision process, let alone the objectives of the decision. Third, of the reviewed articles, only (Estévez et al. 2018; Grubert 2017; Hahn 2015; Nadafianshahamabadi et al. 2017; Singh and Nachtnebel 2016; Stefanovic 2015) mentions the representativeness of the sample of involved stakeholders, but none suggest a way of defining what a representative sample of stakeholders would be. To do that, one must start with defining the stakeholder population as a whole, something which will also be based on subjective value judgments. Fourth, no study included the possibility of stakeholder to update their value elicitations during the process, albeit plausible that at least some stakeholders would have wished to adjust their input based on new information, for strategic reasons or other. Some might argue that strategic elicitations should be prohibited, but it is precisely those that could provide the most intense forms of subjective value judgments.

We recognize the common practice in the reviewed literature to measure subjective values and then apply those value representations normatively to suggest a set of rational acts of decision. However, according to material value-ethics we should be skeptical to any form of ethics which impose certain actions based on so called objective value representations and ethical principles (Kelly 2011). It should be noted that the common meaning of value elicitation exists in acts of decisions made according to some rule or way of reasoning about those value representations.

Accordingly, we point out four issues in particular need of further inquiry of incorporating subjective values in research. First, we call for a thorough investigation into what reasonably can constitute a representative stakeholder sample. Second, we need to find ways of transparently including subjective values early in the research process and keep from resorting to numbers for as long as possible, with a distinct focus on accounting for vagueness and uncertainty. Third, the issue of oversimplification of subjective values for sustainability, and how this affects stakeholder involvement, needs to be explored. Lastly, we believe that information systems must support decision analysts in addressing some of the complexity and challenges with representing, modeling, and otherwise account for subjective value judgments transparently in research conduct. IS solution must not only collect data but also inform the participants on how their input might affect the final output, if it is consistent, etc. For that, we must bridge the gap between the qualitative and the quantitative by using an iterative process and a language with sufficient expressive power that keeps the original meaning of the subjective input values as intact as possible throughout the design and development process of a Green IS solution, for example. A suitable form of subjective value representation for Green IS should allow for vagueness in input and uncertainty about consequences, yet control for consistency, and enhance inclusiveness by being understandable for stakeholders, both in terms of expressive power and method of inference and calculations. Furthermore, there needs to be a way of explicitly treat subjective values when forming the objectives, during the modeling process and when generating the alternatives for design and development of a Green IS solution.

We further suggest a Green IS, advancing the work of, e.g., Thomopoulos (2018), that can support consistent reasoning with subjective values, with the ability to provide feedback about inconsistencies and possible resolutions. However, further investigation is needed about ways in which such a Green IS solution can be constructed, such that deeper reasoning and inclusion of subjective values of various sorts in sustainability can be adequately supported.

Reflective Arguments: Incorporating Subjective Values in Green IS Research

We reflect on our findings through the lens of material value-ethics to conduct impactful Green IS research. Then we offer arguments towards clarifying the role of values in Green IS based on a typology as suggested by Ijad et al. (2010). This has important implications for the spirit of Green IS research and design in a number of ways.

First, a Green IS can account for a set of explicitly stated values, based on the deliberate intention of the designers. However, there are likely to be additional subjective values, held by the designers but not outspoken, which will further influence the number of values supported by the structure and functionality of the information system in question. Naturally, those could remain unknown even to the designers themselves. Only by using meaningful value representations, such that those values can be made transparent, can this to some extent be rectified, while further facilitating active and genuine participation of stakeholders in the design process.

Second, the spirit of a Green IS will be dependent upon the various ways of formalizing subjective values during the design process, in particular, due to the different levels of expressiveness provided by value representations. For example, the ability to communicate subjective values by influencing a model is far different from only being able to supply various limits or parameter values. However, regardless of the choice of expressiveness, there will be room for differences in interpretation of value statements between subjects. Therefore, it is important to consider not only the value statements per se but also the uncertainty surrounding the meaning of those statements.

Third, recall that sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987). Either that holds true for a given development or it does not. Since the future is uncertain, it will eventually boil down to some degree of belief about whether or not it will. Consequently, we will never know if development is sustainable, only that it was not (if that is the case). There needs to be a greater discussion of the ways in which an information system can be considered to be a Green IS, since the bases upon which a decision to call an IS for Green ultimately would lie in an argument based on beliefs about the future. Manders-Huits (2011) suggests an ethical framework be put in place for value-sensitive-design and perhaps it is worthwhile doing the same for Green IS.

The practice perspective will mainly be influenced by the findings pertaining to the use of subjective values in sustainability decision-making. Given that the Green IS provide a basis for decisions, that is true to reality and consistent with some agreed upon definition of what it means to be sustainable, it has a good chance of supplying data that leads to the elicitation of values or decisions about the time horizon that conforms to a sustainable practice. As should be evident at this stage is the importance of finding a way by which a common notion of a context-dependent concept of sustainability (c.f., Norton 2015) could be constructed. We argue that it would be counter-productive to provide a definition of sustainability that is valid irrespective of the context due to the immense need for oversimplification to realize such a venture (if it by any means would be possible). However, the practice is also influenced by the formalization and the ways in which input can be supplied and by which methods (calculations, conversions, aggregations, etc.) the input is treated or converted. Using a common language for determining sustainability whatever the context might, however, be beneficial in supporting commensurability between outcomes and the valuation of various tradeoffs, even when the alternative actions concerns different conditions. Yet another option is to state, more precisely, the desired impact of any Green IS, such as decrease of emissions, rather than adhering to the vague and immeasurable notion of sustainability.

This paper has less of a bearing on issues about the impact perspective of Green IS which concerns unintended consequences, since sustainability decision-making herein is related to the conscious and orchestrated activity of making choices consistent with subjective beliefs and values. Nevertheless, unintended need not be equal to unthinkable, and so subjective beliefs about the complete set of possible outcomes would still be of some relevance to this perspective. Whether or not something is sustainable cannot be evaluated based solely on the perspective and knowledge of present generations. Hence, a thorough discussion about ethical implications and uncertainty pertaining to the outcomes ought to accompany Green IS-related works. We must also acknowledge that even though the future is uncertain,

sustainable development requires that we meet the needs of future generations as well as the needs of the present. The latter is something which we can influence and contribute to, based on our beliefs about the future, and Green IS can be a powerful tool in that process.

Conclusion

In this paper, we aim to understand subjective values and clarify their role in Green IS by reviewing and synthesizing the body of knowledge that describes and incorporates subjective values in sustainability decision-making and Green IS research. The results indicate that although the importance of incorporating subjective values in sustainability decision-making is recognized, both in research and practice, no sufficient representation of the subjective values is made within the decision analysis process. The state of the art methods used for formalizing subjective values tend to oversimplify the "meanings" and "contextual information" embedded in these subjective values, which devalues much of the current use of these values in sustainability decision-making. Drawing upon these important findings, we argue that the implicit incorporation of subjective values in Green IS research has critical and significant implications for its outcomes.

The understanding and consideration of subjective values in Green IS research should receive considerable attention and become a focal point of inquiry. In particular three types of issues should be addressed: (1) the degree to which subjective value-judgments concerning choices of research design should be made explicit; (2) how subjective value statements of different types ought to be represented in methods and models, in order to provide a sufficient level of expressiveness; and (3) because any value judgment ultimately rests on "primal feelings" in a situated condition, in particular about uncertain future outcomes, the design and implementation of Green IS should include a thorough discussion about ethical implications and risks, especially concerning the ability of future generations to meet their own needs.

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