SENSEMAKING AND SUSTAINABLE PRACTICING: FUNCTIONAL AFFORDANCES OF INFORMATION SYSTEMS IN GREEN TRANSFORMATIONS

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Appendix A

Literature Analysis

We view sustainability transformation initiatives as a special case of large-scale IT-enabled change projects. To identify what is particular about these initiatives, we examined the literature in information systems, organizational science, and management and identified six key properties that apply to sustainability transformation initiatives. A summary of these key properties and their implications for our study is presented in Table 1 in the body of the paper.

1. Sustainability transformations are not purely motivated by economic imperatives. Economic motives, such as capitalizing on environmentalism as a commodity (Egri and Herman 2000), instead form only part of a complex net of regulative, normative, and cultural-cognitive pressures (Butler 2011). These pressures increasingly originate from a societal context in which there is a growing awareness that the environment is in imminent danger (Melville 2010).

    Importantly, the regulative, normative, and cultural–cognitive pressures originate from the external context of an organization. For instance, organizations often undertake sustainability transformations due to normative or cultural–cognitive pressures exerted by standardization bodies (Ryan 2008), investors (Mincer 2007), or supply chain partners (Rao and Holt 2005) within their institutional environment.

2. Environmental sustainability is a multilayered and complex phenomenon. It relates to environmental, societal, governmental, organizational, regulatory, as well as individual factors (Elliot 2011; Melville 2010; Pitt et al. 2011). Organizations may be affected in terms of standards (Corbett and Kirsch 2001), organizational operations (Klassen and Jacobs 2001), regulatory mechanisms (Lyon and Maxwell 2007), or technology (Petrini and Pozzebon 2009) and management (Bansal and Roth 2000).

3. Organizational sustainability transformations rely on managerial interpretations of environmental issues as threats (Bazerman and Hoffman 1999) or opportunities (Bansal and Roth 2000), and the definition of an accordant strategy (Sharma 2000) and actionable policies (Ramus and Steger 2000).

    The emerging environmental considerations need to be integrated with existing organizational values, norms, and regulations, which creates a demand for an increased multidisciplinarity and interrelatedness of information. This information originates from various internal and external sources, but how it is used and disseminated is not yet present in our understanding of how information systems can fit individual and organizational task settings in light of environmental considerations (Pitt et al. 2011).

4. Sustainability transformations involve both utilitarian and nonutilitarian goals. Organizations often identify a utilitarian opportunity in becoming environmentally sustainable (Dyllick and Hockerts 2002) while, at an individual level, environmental sustainability is associated with nonutilitarian values such as altruism (Melville 2010) and ecological awareness (Collins et al. 2007).

    An organizational sensemaking process is thus required that allows individuals to adopt such new values, and identify and implement new goal settings for their work practices and social actions. The top management definition of environmental policies is suggested as a key measure to that effect (Ramus and Steger 2000). Organizations have also introduced local "sustainability champions" to motivate employees to ascribe to values of sustainability-aware employees (Collins et al. 2007) and the acceptance of environmental norms as guiding principles for their actions (Cordano and Frieze 2000). How information systems can assist individuals in their attempts to identify environmentally sustainable work practices, however, is yet to be understood.

5. Sustainability transformations pose new requirements for information systems solutions in their support of organizational work practices. This includes reduced carbon emissions (Zhang et al. 2011), eco-compatible lifecycle management (Capra and Merlo 2009), and increased energy efficiency (Bose and Luo 2011) of such systems.

6. Information systems assume a position of unique duality in that they can be both a contributor (DesAutels and Berthon 2011; Zhang et al. 2011) and a potential solution to environmental degradation (Elliot 2011). Some of the positive potential of information systems is argued to reside in the ability to enable the management of compliance imperatives (Butler 2011), to contribute to sustainable human behavior (Elliot 2011; Melville 2010), to enable the development of sustainable capabilities (Dao et al. 2011), to form beliefs about environmental sustainability (Melville 2010), and to allow for environmentally sustainable business processes and products (Watson et al. 2010). How and when such positive ramifications materialize from information systems, however, remains largely unknown.

Appendix B

Methodological Details

Data Collection

As a primary source of data, we conducted semi-structured, open-ended interviews with selected key personnel involved in the organization's sustainability initiative, and with software developers and consultants that were not directly involved in the organization's sustainability initiative but in the core processes of the organization (i.e., IT solution development and solution delivery). We were interested in both the perspectives of those driving the transformation process, and those being affected. Table B1 summarizes the iterative evolution of the interview process and provides interviewee demographics.

The interviews were designed based on a set of preplanned questions to cover the subject area (Rubin and Rubin 2004). Our intent was to cover the initiative broadly and deeply, to allow for inductive generation of theory from the data. The interviews were guided primarily by four key issues:

•   why the organization engaged in a sustainability transformation
•   how work practices of individuals and groups changed in the light of environmental objectives
•   how IT contributed to the development of a sustainable enterprise
•   which factors in general pertained to the IT-enabled transformation

Table B1. Summary of Interview Data Collected					
Stage	**Respondent**	**Position**	**Location**	**Gender**	**Date and Duration of Interview**
Phase One: Interviews with internal members of sustainability operations	A	Head of Sustainability Operations	Germany	Male	28-10-2009, 1h06min
	B	Member, Sustainability Leadership Board	Germany	Female	28-10-2009, 1h11min
	C	Member, Sustainability Leadership Board	United States	Male	30-10-2009, 1h19min
	D	Member, Sustainability Leadership Board	Switzerland	Male	26-10-2009, 1h30min
	E	Head of Change Management	India	Female	09-03-2010, 59min
	F	Sustainability Champion	India	Female	17-03-2010, 1h
	G	Sustainability Champion	Unites States	Male	17-03-2010, 1h
	H	Sustainability Champion	Germany	Male	22-03-2010, 57min
	I	Responsible for setting up the Champions Network	Germany	Male	09-06-2010, 1h09min
	A (second interview)	Head of Sustainability Operations	Germany	Male	17-06-2010, 1h04min
Phase Two: Interviews with consultants and developers as the affected audience	J	Consulting Manager	Germany	Female	07-02-2011, 59min
	K	Product Owner	Israel	Male	09-02-2011, 52min
	L	Project Manager in software development	Germany	Male	09-02-2011, 43min
	M	Quality Engineer	India	Male	09-02-2011, 58min
	N	Consultant	Germany	Male	09-02-2011, 35min
	O	Senior Software Engineer	India	Male	10-02-2011, 35min
	P	Consultant	Germany	Male	10-02-2011, 39min
	Q	Project Manager in software development	Germany	Male	11-02-2011, 52min
	R	Senior Software Engineer	India	Male	11-02-2011, 22min
	S	Manager for business development	United States	Male	14-02-2011, 32min
	T	Project Manager	Germany	Male	15-02-2011, 58min

In the interviews, we allowed for further follow-up inquiries in order to gain a deeper understanding of the subject matter or to clarify individual responses. We conducted multiple rounds of interviews, where the protocols were refined based on initial model development. The interview questions, over time, became more detailed and focused on specific topics and main themes that emerged from the data. Appendix C shows the interview protocol used at the later points of data collection and thus denotes the evolved protocol that already focused on concepts and themes that emerged during our data exploration. For instance, note how the protocol shown in Appendix C examined the meta categories provided by socio-technical systems theory as a rough structure, as was emerging over time through our coding.

The interviews were conducted in English. Overall, the interview length was between 30 and 90 minutes each, with an average of about 55 minutes. Interviews were conducted from October 2009 to February 2011. Interview sampling was directed by evolving theoretical concepts; that is, we went to places and people from which we expected the most insights into the phenomenon under investigation (Strauss and Corbin 1998). For example, we initially interviewed chief executives and top-level managers involved in the sustainability change operation at the case organization and sustainability champions that were engaged at the local level. Over time, when focusing on the changes on an individual work practice level, we approached consultants, developers, and other employees not directly related to the sustainability program but affected by it. The data from the recorded interviews were captured in approximagely 250 single-spaced pages of transcribed interviews. Key interviews were summarized and reviewed by relevant stakeholders.

A second important source of data was case documentation about the initiative. At the case site, all relevant documentation about the transformation program is maintained as the so-called *Sustainability Report*—an interactive web page created by the sustainability operations workforce in the case organization. The web page is a living document continuously updating relevant information about the initiative, while

allowing for feedback and user engagement through a "live feedback" functionality similar to social networking web sites and also including microblogging functionality. This data source allowed us to gather data on key performance metrics (e.g., carbon footprints, consumption of renewable energy, data center energy, etc.) related to the transformation, key information about plans and strategies for upcoming solutions (e.g., related to resource productivity, sustainable consumption, or risk management), as well as feedback from throughout the case organization, through functions such as "Tell Us What's Important," "Give Us Your Feedback," and other interactive dialogue mechanisms.

Coding and Analysis Procedures

We followed a three-stage process of open, axial, and selective coding, building upon and adapting the recommendations of Strauss and Corbin (1998). This coding and analysis strategy is well established in the literature (e.g., Berente et al. 2011; Bryant et al. 2004; Urquhart et al. 2010). Our instantiation of this approach is described in the following and summarized in Figure B1. Figure B1 also provides an example illustration of our coding and analysis, in which we show how the concept of *reflective disclosure* was identified, contextualized, and integrated based on the data collected.

The three stages of open, axial, and selective coding were highly interwoven (Strauss and Corbin 1998). During the early stages of coding, we identified initial concepts (such as *creating transparency*, *virtual collaboration*, and *individual awareness*) and relationships (such as between *creating transparency* and *individual awareness*), which then guided further theoretical sampling, data analysis, and the ongoing process of model development. The different stages of coding, and their interrelationships, are described in turn.

Our initial stage of analysis (open coding) aimed at identifying concepts and higher-level categories based on the data collected. With the goal of understanding the transformation process, we were particularly interested in the factors and relationships associated with the change of work practices and the role of IT therein. At the same time, however, we tried to remain as open as possible in order to identify concepts and relationships that were salient in the data (Klein and Myers 1999). All interviews were coded line by line. We used constant comparison to cross-examine the responses from different interviewees, in an effort to group answers pertaining to common codes as well as to analyze different perspectives on emerging codes. This process produced well over 200 codes, which were further grouped and integrated, resulting in a set of concepts that were again grouped under more abstract categories. *Data monitoring,* for example, was a concept that originated in open codes such as *data collection* and *performance measurement*.

In the process of axial coding, categories were further developed in terms of underlying concepts and properties. Also, relationships among categories were identified (Strauss and Corbin 1998). Axial coding thus served to further develop and elaborate the major categories that emerged from our analysis (Charmaz 2006); we coded around the axes of the main categories.

At this stage, we used the concept of functional affordances as a theoretical lens, as we realized that information systems had to be seen as permitting action possibilities, rather than deterministically leading to consequences (Markus and Silver 2008). The use of theory in this situation is warranted, as it allowed us to create an initial theoretical framework that informed the categories of the initial coding and also took into account previous knowledge from the literature (Walsham 1995).

Specifically, STS theory allowed us to situate the functional affordances within the socio-technical context in which they occurred. This was important because we needed a framework to examine the information systems use context (Leonardi 2011) in which affordances originated and in which they were realized. We thus used these theoretical lenses in order to identify relationships and elaborate the axial categories, instead of drawing on Strauss and Corbin's (1998) paradigm model, which suggests grouping concepts into conditions, phenomenon, action, strategies, and consequences. Using these theoretical lenses also allowed us to frequently relate our analysis to the key guiding questions we identified for our research (see Table 1).

Drawing on these frameworks, the data were recoded and concepts were rearranged. Specifically, we found that the functional affordances of *reflective disclosure* and *information democratization* (further grouped under the more abstract category of *sensemaking),* and *output management* and *delocalization* (further grouped under the category of *sustainable practicing)* allowed for a conceptualization that promised to provide explanations that could answer our research question. These four categories thus became the main axes around which we coded (Charmaz 2006). The other categories could be linked to the affordances as either providing the material properties of information systems (e.g., the category of *monitoring, analysis, and presentation features* [technology component of STS]) or constituting part of their use context (e.g., the categories of *user characteristics* [people component of STS]*, management intervention* [structure component of STS]*,* or *reassessment and participation* [task component of STS]). For instance, compare how in Figure B1 the concept of *data monitoring* was identified as a *material property of IT* that contributed to the emergence of the *reflective disclosure affordance*. *Action goals, awareness, attitude,* and *motivation*, for instance, were important *user characteristics* which, in turn, contributed to constituting the use context of the emergent affordance. For each of the main categories identified through this process, we created an integrative memo that was the outcome of axial coding and was then further detailed, and integrated, during the stage of selective coding (Sarker et al. 2001).
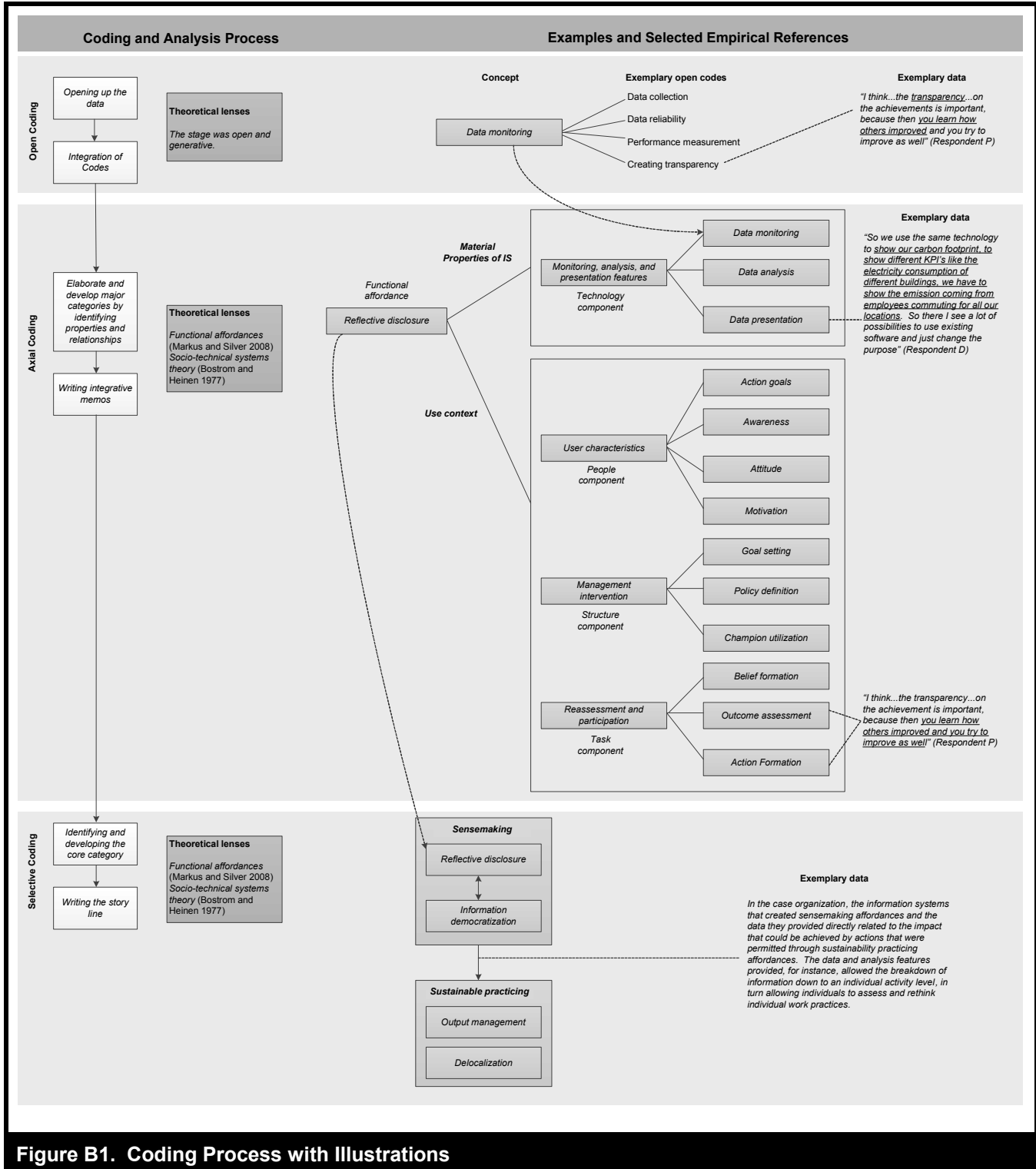
Coding and Analysis Process	Examples and Selected Empirical References

Open Coding

Opening up the data

Integration of Codes

Theoretical lenses

The stage was open and generative.

Concept

Exemplary open codes

Exemplary data

Data monitoring

Data collection

Data reliability

Performance measurement

Creating transparency

"I think...the transparency...on the achievements is important, because then you learn how others improved and you try to improve as well" (Respondent P)

Axial Coding

Elaborate and develop major categories by identifying properties and relationships

Writing integrative memos

Theoretical lenses

Functional affordances (Markus and Silver 2008) Socio-technical systems theory (Bostrom and Heinen 1977)

Material Properties of IS

Functional affordance

Reflective disclosure

Use context

Monitoring, analysis, and presentation features

Technology component

Data monitoring

Data analysis

Data presentation

Exemplary data

"So we use the same technology to show our carbon footprint, to show different KPI's like the electricity consumption of different buildings, we have to show the emission coming from employees commuting for all our locations. So there I see a lot of possibilities to use existing software and just change the purpose" (Respondent D)

User characteristics

People component

Action goals

Awareness

Attitude

Motivation

Management intervention

Structure component

Goal setting

Policy definition

Champion utilization

Reassessment and participation

Task component

Belief formation

Outcome assessment

Action Formation

"I think...the transparency...on the achievement is important, because then you learn how others improved and you try to improve as well" (Respondent P)

Selective Coding

Identifying and developing the core category

Writing the story line

Theoretical lenses

Functional affordances (Markus and Silver 2008) Socio-technical systems theory (Bostrom and Heinen 1977)

Sensemaking

Reflective disclosure

Information democratization

Sustainable practicing

Output management

Delocalization

Exemplary data

In the case organization, the information systems that created sensemaking affordances and the data they provided directly related to the impact that could be achieved by actions that were permitted through sustainability practicing affordances. The data and analysis features provided, for instance, allowed the breakdown of information down to an individual activity level, in turn allowing individuals to assess and rethink individual work practices.

Figure B1. Coding Process with Illustrations

During selective coding, we integrated the major categories in order to form a larger theoretical scheme (Strauss and Corbin 1998). We found that the functional affordances of sensemaking and sustainable practicing pulled the other categories and concepts into a coherent whole. For example, compare how in Figure B1 the sensemaking affordances were integrated with the sustainable practicing affordances. These functional affordances thus became the core categories of our research. Finally, once these core categories emerged, we related them to existing literature (Bryant and Charmaz 2007; Sarker et al. 2012).

Credibility, Corroboration, and Generalizability of Findings

Our research is interpretive in nature and thus our analysis subjective and emergent in nature. While traditional notions of reliability and validity do not apply similarly to this type of research (Lincoln and Guba 1985), several scholars (e.g., Klein and Myers 1999; Myers 2009; Walsham 1995) have provided alternative guidelines to ensure rigor in interpretive research.

Specifically, interpretive researchers should (1) provide a clear chain of evidence (Walsham 1995), (2) consider alternative explanations, multiple view points, potential biases, and distortions (Klein and Myers 1999), (3) corroborate their findings and aim for theoretical saturation (Strauss and Corbin 1998), and (4) aim at generalization beyond the substantive area under investigation (Klein and Myers 1999; Lee and Baskerville 2003). In our analysis, we took care in considering these guidelines.

First, we sought to provide a traceable, documented justification of the process by which we reached conclusions about the research from the data. The interviews were recorded and verbatim transcriptions were generated in order to minimize the threat of inaccuracies and to allow for a line-by-line coding of data. Congruent with other published interpretive case studies (e.g., Davidson and Chismar 2007; Holmström Olsson et al. 2008; Ng and Gable 2010), we used a case study protocol that contained an overview of the research topic, case study questions, and interview procedures that guided evidence collection and analysis. We maintained a case study database on a shared drive that served as a readily accessible central store of data and information references collected; it is comprised of all of the accessible documents, interview transcripts, interview audio recordings, databases, case study notes, e-mails, as well as an annotated bibliography and literature relevant to each of the emerging concepts. We used the qualitative data analysis tool NVivo in order to analyze our data and to maintain traceability of the coding and the evolution thereof.

Second, we aimed for corroborating our findings by using different data collection methods (interviews and documents) and data sources (different respondents from different units and levels across the organization, as well as primary and secondary documentation about the initiative) in order to lessen the likelihood of important omissions and to substantiate the emergent concepts (Strauss and Corbin 1998). We involved two analysts (the first and the second author) in the process of data analysis and conceptualization to cross-check and corroborate the interpretations made in this research. This process also allowed us to contrast, challenge, and resolve conflicting individual interpretations of the data (Klein and Myers 1999). Finally, we had key respondents at the case site confirm the study data, the researchers' interpretations of the data, the study conclusions, and all other study outputs (Myers 2009).

Third, we were aware of the multiple interpretations due to the differences in interpretations among the participants in particular (Klein and Myers 1999). We thus aimed to understand multiple viewpoints, and consider these in our analysis. We believe that the theoretical lens of affordances allowed us to develop a contextual understanding and to reconcile and integrate different viewpoints. For example, our study suggests that individual awareness influences the emergence of functional affordances: while some individuals—due to their awareness and motivation—perceived information systems to provide sensemaking affordances, others—due to a lack of awareness and motivation—did not.

Fourth, concerning generalization of the findings beyond the substantive domain studied, we are aware that this is limited in this type of research (Myers 2009). Still, it has been argued that research that develops theoretical concepts and specific implications from the data collected presents a type of generalization that involves moving from measurement, observation, or other description to a theory (Lee and Baskerville 2003; Walsham 1995). This definition applies to the work presented in this paper. Specifically, we prepared for the generalization of findings beyond the single case that was studied by relating the observed unique instances to "ideas and concepts that apply to multiple situations" (Klein and Myers 1999, p. 75). By bringing in the theoretical lenses of functional affordances and STS theory, and also engaging with prior literature from Green IS, we were able to relate the idiographic details as revealed by our interpretation of the data to theoretical concepts. As indicated above, we made sure that those abstractions were carefully related to the case data, thus allowing for traceability and plausibility of our reasoning and conclusions (Klein and Myers 1999).

Appendix C

Interview Protocol �

Interview Introduction

Global crises such as rapid climate change and the social divide force individuals, organizations, and governments to increasingly debate on solutions for an environmentally sustainable economy.

In cooperation with the BPM Group at Queensland University of Technology, the BPM Group at the University of Liechtenstein has been investigating the transformation process towards sustainable enterprises. In this interview, we aim to get an in-depth understanding of the role that **information technology** plays in the internal transformation process of [*case organization*].

Interview Questions

The following questions will be asked during the interviews. Each of the questions may be followed by further follow-up questions in order to gain a deeper understanding of the subject matter. The interview length will be between 60 and 90 minutes. After receiving consent, the interviews will be audio taped.

Introduction
A) Background/context
- What is your position within [case organization]?
- What projects do you typically/currently work on?
- What is your understanding of sustainability?
- Does sustainability play a role in your daily work practices? If yes, please describe it.
- What do you know about the internal transformation of [case organization] towards a sustainable organization?
- Are you aware of [case organization] Sustainability Operations?
- Do you have any tasks and responsibilities that are directly related to the sustainability transformation?
- Have your daily work practices changed since [case organization] has been engaging into the sustainability transformation? If yes, how?
- Does sustainability play a role within the projects you work on? For the clients? For [case organization] internally?
- What do you think are the consequences of this transformation process?
    - For [case organization] internally?
    - For current or future customers of [case organization]?

B) Process change at [case organization]
- Do you think that [case organization]-internal processes need to change to become a more sustainable organization?
- Do you remember whether and how any work processes that you are involved in changed as part of the sustainability initiative? If so,
    - Can you describe the process before and after the change?
    - What has changed?
    - How did this change occur?
    - Do you recall a critical incident or any other trigger that started the change? (E..g., you learned about sustainability metrics; a consultant provided stimulating inputs; you were directed to change your work; a formal process review took place; a technology enabled you to work differently; or you learned about what other individuals or teams did at [case organization].)
    - Was the change triggered by sustainability objectives or part of other initiatives?
    - Was a new or existing IT system involved in the change (e.g., as a trigger, or as an enabler, or as a facilitator)?
- Looking at the team or workgroup you usually work with, would you say that the team processes changed as part of the sustainability initiative? Why or why not? If so,
    - Can you describe the process before and after the change?
    - What has changed?
    - How did this change occur? (E.g., did a member of the team/group lead the change, was it driven by mandate, did you start using a new technology or system.)
    - Was a new or existing IT system involved in the change (e.g., as a trigger, or as an enable, or as a facilitator)?

- Looking at [case organization] business processes in general, how do you think should [case organization] processes be changed to become more sustainable? Is this what has happened at [case organization]?
- Do you think the process changes at [case organization] were driven primarily by technology, changes in work practices, or by managerial mandate?

C) The role of information technology (IT)
- What role does IT play in your work processes?
- What is your understanding of the term "Green IT"?
- Based on your understanding, is [case organization] using Green IT? Should [case organization] use Green IT? Are you using Green IT?
  - **Exemplary sub-questions**
    - Do you know about any tools that are used at [case organization] in order to foster "virtual" collaboration?
    - Do you know about any tools that are used in order to enable or increase communication?
    - Do you receive information about [case organization]'s progress in the sustainability initiative? Where do you receive such information from?
    - Do you know about any sustainability-related KPIs and measures that are used within [case organization]?
    - Do you know about any tools that are used internally in order to monitor sustainability-related measures?
    - Do you have access to such tools?
    - Do you use these tools? For what purpose?
    - How did you learn about these tools?
    - If you do use the tools, what experiences have you made using them?
    - What do you think is the impact/consequence of using these tools?
    - Do you think there are any alternatives to using these tools?
    - Would you regard IT to be a key factor in enabling sustainability transformation? Why or why not?
    - Can you think of any other roles that IT plays with regard to sustainability transformation?

D) The role of the individual
- What do you think is the role of the individual in the overall transformation process at [case organization]?
- To what extent do you think individuals need to change their behavior in order to allow the transformation toward a sustainable enterprise?
- Do you think that [case organization] has been motivating or asking for individual behavioral change to become a sustainable enterprise? If so, how was this achieved or not achieved?
  - Can you recall any means used to foster individual change?
  - Can you recall any incidents that affected or triggered people to change their behavior?
  - Is there a role that IT played in fostering individual change?
- To what extent do you think has [case organization] been successful in creating awareness for sustainability among their employees?

E) The role of management
- What do you think is the role of [case organization]'s organizational management (e.g., rules, policies, etc.) in the transformation process?
- How important do you deem the establishment of KPIs in order to allow for the transformation towards a sustainable enterprise?
- How well has [case organization]'s management communicated the sustainability initiative's ambitions, actions, and outcomes throughout the organization? How would you rate the communication's effectiveness? What means for communication were used by management?
- Is [case organization]'s organizational management using IT to manage the transformation process? If so,
  - Which systems are they using? How are they using the systems?
  - Were these systems in place prior to the sustainability initiative?
  - Is the management's use of IT effective in regard to the sustainability initiative?

F) What else?
- Did we forget anything? Is there anything else you would like to discuss?
- Could we get back to you in case we have some (minor) further questions from our data analysis?

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