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DISCUSSION

On the Pivotal Role of Data in Sustainability Transformations

Challenges and Opportunities

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1 Introduction

Lea Püchel and Cancan Wang

Data is increasingly viewed as a crucial strategic asset for organizations aiming to secure a competitive advantage (Galliers et al. 2017; Günther et al. 2022). Unlike traditional resources, data is highly portable and can be easily transferred and applied in various contexts, often beyond its initial purpose (Günther et al. 2022). Yet, an overlooked context within the information systems (IS) literature lies in theorizing the relationship between data and sustainability (Krasikov and Legner 2023; Machado Ribeiro et al. 2022). This is a significant missed opportunity, given the urgency of sustainability issues with six out of nine planetary boundaries already crossed and limited progress on the sustainable development goals (SDGs) formulated by the United Nations.

The significance of data, however, is increasingly being highlighted in applied domains. The United Nations (UN) has emphasized the need for data to monitor and, ideally, fulfil the SDGs, calling for "big data for sustainable

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development" in the public sector (United Nations 2024). The European Sustainability Reporting Standards (ESRS), which accompany the European Union's (EU) 2022 update of its corporate sustainability reporting requirements, requirements which apply to many companies in the bloc, also assume the provision of a wide range of sustainability-related data. Alike, consultancy reports and private industry practices emphasize the necessity for organizations to use data analysis and data management in promoting sustainable business practices and decisions. These transformative processes are often referred to as "data-driven sustainability" (Deloitte Development LLC 2021). By embracing data-driven sustainability initiatives, organizations can leverage data to efficiently establish more sustainable ways of working and achieve environmental, social, and economic sustainability goals. Some reports even propose that, given the striking synergies between the digital and the sustainability transformation, we should speak of the "twin transformation" (Christmann et al. 2024). This understanding highlights the strategic use of data to inform decisions and foster innovations that actively contribute to sustainability objectives, positioning digital applications and data as a crucial resource for driving positive societal change and advancing organizational sustainability.

IS scholars' extensive efforts on data studies (see e.g., Aaltonen et al. 2021; Alaima and Kallinikos 2022, 2024; Faulkner and Runde 2019; Galliers et al. 2017; Günther et al. 2022; Jarvenpaa and Essén 2023; Jones 2019; Mikalsen and Monteiro 2021) provide a range of sociotechnical constructs that offer valuable insights into understanding and shaping the relationship between sustainable development and data. In particular, data is recognized for its representational capacity (Mikalsen and Monteiro 2021) and performative effects that are deeply embedded in institutional processes (Alaimo and Kallinokos 2024; Parmiggiani et al. 2022). Fundamentally, data in IS studies is seen as a digital representation of information that is referential andexists on a continuum between natural and subjective information, providing a basis for analysis (Jones 2019). This allows for a critical examination of data establishment and usage (Jones 2019; Parmiggiani et al. 2022). Above all, if data is placed in the digital technology continuum, which means that it is understood as digital technology in sociotechnical management, it can have transformative potential (Besson and Rowe 2012; Christmann et al. 2024; Ilieva and McPhearson 2018; Vial 2019).

In the context of sustainable development, sociotechnical constructs underscore the interplay between technological and social subsystems, which is crucial for implementing sustainability solutions that are not only technologically sound but also economically, environmentally, and socially responsible, addressing the triple bottom line of the sustainability definition (George et al. 2021). For instance, understanding the performative nature of data (Alaimo and Kallinokos 2024; Parmiggiani et al. 2022) helps organizations see how data not only reflects but also shapes environmental policies and practices. This critical perspective allows for the design of IS that actively contribute to sustainable development by influencing behaviors and decisions at multiple levels – from individual actions to corporate strategies and policy formulations. This approach ensures that sustainability is embedded not as an afterthought but as a foundational element leveraging it to create transparency of progress and drive change toward sustainability goals.

In sociotechnical IS processing, data undergoes progressive modifications, combinations, and computational manipulation that increasingly abstract it from its original physical references, turning data into conceptual symbols of events that are otherwise not directly observable (Mikalsen and Monteiro 2021). The potential of data to serve as a representation and enabler is thereby not always fully realized, neither in practical or in theoretical scenarios. For data to be effectively integrated into impactful daily work practices, thus becoming an enabler of a competitive advantage and last but not least a driver of the sustainability transformation, its representation must be accurate and closely aligned with the phenomena it aims to depict.

Yet, a significant gap exists in the IS literature regarding the enabling influence of "data" in organizational sustainability transformation (Krasikov and Legner 2023; Machado Ribeiro et al. 2022). While in practice sustainability data is often primarily collected for compliance purposes, it can potentially drive transformation within the organization and vice versa (Malhotra et al. 2013). In this discussion paper, we focus on the IS archetypes of these transformational approaches and their implications for an organization's sustainability transformation. More specifically, this contribution discusses how data is linked to sustainability initiatives and asks: "*What needs to be done to unleash the full potential of data for the sustainability transformation?*".

1.1 The Relationship(s) between Data and Sustainability

The aim of this section is to create a foundation for a shared understanding of the relationship between data and sustainability and lay out a brief historical account of IS research important in this regard.

A first step to filling the above-mentioned gap is to revisit the definition of transformation as it provides a foundational platform for theorizing about the distinct

characteristics of data that are pertinent for various sustainability objectives. The Latin word "transformare" connotes a change of form, with "trans" referring to something in the middle, above, under, or simply in movement from one level to the next (Merriam Webster Dictionary 2024). This means that in order for data to have transformative potential, it must enable a profound change, for example at the highest organizational and societal levels.

IS research broadly follows the definition of sustainability by the United Nations (UN) Brundtland Commission, which refers to "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations, Report of the World Commission on Environment and Development 1987). Therefore, when we speak of the sustainability transformation, we mean the transformation of organizations, communities, and societies in a way that aligns with the principles of the 2015 United Nations Sustainable Development Goals (UNSDGs or SDGs). Focusing on sustainability and IT, IS research draws on the concept of the triple bottom line or "three P's (people, profit, and planet)", emphasizing that businesses should integrate environmental responsibility and social impacts into their operations (Kotlarsky et al. 2023; Melville et al 2017). More specifically, IS research has investigated sustainability and technologies from two complementary angles, namely Green IS and Green IT.

Green IS research primarily focuses on businesses' sustainability efforts and explores how technologies can potentially enable organizational sustainability objectives (e.g. Kotlarsky et al. 2023; Leidner et al. 2022; Hedman and Henningsson 2016; Malhotra et al. 2013; Seidel et al 2013). Most Green IS studies have dealt with the ecological dimension of sustainability (Kotlarsky et al. 2023), suggesting a trade-off between the dimensions of the triple bottom line (George et al. 2021). Following the advent of the UNSDGs in 2015, Green IS researchers began to emphasize the importance of incorporating both social and ecological values into businesses' financial value proposition (Kotlarsky et al. 2023; George et al. 2021). For instance, George et al. defined "digital sustainability as the organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data" (2021, p. 1000).

As a complementary perspective, Green IT is concerned with the sustainable performance of information technology, infrastructure and equipment and their impact on the environment (e.g., Loeser 2013). While there is some research on the design of Green IT (Alvarado et al. 2023; Ardito et al. 2015; Uddin and Rahman 2012), there is somewhat less research on its translation for this and integration into organizational and sociotechnical frameworks (e.g. Loeser et al. 2017). As data usage increases, this is problematic as the hardwired backbone of digital data are data centers that have a very material impact on energy consumption (Dodge et al. 2022).

Although both Green IS and Green IT research have highlighted the importance of data work (e.g., monitoring energy consumption) as an integral part of organizations' sustainability efforts, they have also reported a lack of meaningful sustainability data in practice. Among the most pressing problems is the lack of data accessibility, availability, and quality (Krasikov and Legner 2023). Despite the increasing concern among practitioners and academics about the data on corporate environmental, social and corporate governance (ESG) performance (e.g., Vergara and Agudo 2021), there is also a lack of attention to the enterprise information systems that generate and manage these data and how they are embedded in sociotechnical relations (Melville et al 2017; Seidel et al. 2013). A 2020 special issue in the Journal of Association for Information Systems was launched to initiate the research on how to embed data work in IS, focusing on data-driven approaches (Ketter et al. 2020). In that issue, researchers pointed out the opportunities for Green IS design offered by the increasing availability of large-scale ESG data, while also highlighting issues such as inconsistent data collection methodologies or difficulties in data integration due to lack of standards that can prevent such data from yielding meaningful insights and transforming organizations towards sustainability. Additionally, the availability of data alone is not sufficient to unlock its enabling potential. Previous research has highlighted the importance of sensemaking processes in leveraging data effectively (Lycett 2013; Parmiggiani et al. 2022). These processes are critical, yet not fully comprehended, especially in the context of big data. Understanding how data is to be interpreted and utilized in decision-making remains a key area for investigation in the IS field.

Through the propositions in this paper that discuss how data and sustainability can be shaped in IS management, this paper contrasts regulatory and transformational management approaches as well as informational and transformational data provision. When contrasting regulatory and transformational management approaches, the authors discuss compliance-focused data usage (providing information to external stakeholders) and transformation-focused strategies (aimed at internal learning and improvement). When contrasting informational and transformational data provision, an informational approach views reporting as a mechanism to inform stakeholders, such as investors and regulators, effectively using data as a tool for external transparency. In contrast, a transformational approach sees reporting as a catalyst for internal

change and learning, suggesting that how data is handled internally can lead to substantial organizational improvements and an adaptation towards sustainability goals.

Overall, this discussion thereby implies that IS researchers need to shift to a performative view of sustainability data in order to better understand how sustainability data can realize its transformative potential. Such a view is – as explained above – already established in general IS data studies and acknowledges the mutual influences between technical and social structures. A performative view of sustainability data directs our attention to the sociotechnical actions necessary to use data work for sustainability (Parmiggiani et al. 2022) and re-embed sustainability data in different data production and use practices. If followed, we suggest that data can become an indispensable mediator between the social, economic and environmental dimensions of sustainability that need to be understood and changed to arrive at transformational pathways. The question remains, how exactly these relationships are shaped in IS management.

1.2 Introducing the Different Subsections

To provide initial answers and emerging areas for research related to data and sustainability, *and to answer the question what needs to be done to unleash data's potential for sustainable development*, we invited researchers and practitioners who took part in the 1st Conference on Sustainability and Data to share their views. The trans- and inter-disciplinary conference took place virtually on September 12, 2023, and brought together practitioners and researchers in a unique format, in which both groups entered a dialogue on how to address management issues around sustainability and data.

Our goal in this discussion was to bring together trans- and inter-disciplinary insights toward better understanding the complex sociotechnical relationship between data and sustainability. We have chosen different conceptualizations not only because they represent major research foci in their respective fields, but more importantly because a multi-focus on the distinctions expands our collective understanding of both the social and technical influences on data and the data management for the sustainability transformation – an effort particularly needed in sustainability. In the following six perspectives are presented that draw propositions from the contributors' scientific and practical works, discussing the interplay between data and sustainability from a regulatory, organizational, processual, and transformative perspective.

Karin Buhmann sheds light on the regulatory pressures leading to a surge of data requirements based on sustainability-oriented non-financial reporting (NFR) requirements. Comparing the *transformational approach to NFR* that is designed to help companies learn from within and contribute to organizational change, with the *informational approach to NFR* that focuses on providing information to external stakeholders such as media and financial institutions, Buhmann's discussion draws attention to the importance of aligning overall sustainability objectives and regulatory strategies with data requirements so as to stimulate sustainable business behavior rather than simply identify and share data on performance.

Tobias Brandt approaches sustainability transformation and sustainability reporting through the broader lens of organizational data management. Drawing parallels to recent efforts related to general data analytics, he argues that lacking data management practices is a critical obstacle which organizations need to overcome. He postulates that sustainability reporting requirements may force organizations to overhaul their data management practices and infrastructures, leading to potential benefits beyond those related to the sustainability transformation.

Jan vom Brocke presents a process science view on capturing and analyzing data to advance sustainability research. He argues that process science provides a new lens for studying the emergence of sustainability, i.e. by analyzing digital traces capturing data on both the behavior in organizations and changes in the environment. He discusses how to apply the process science framework for sustainability research, specifically how to integrate data from diverse sources and to analyze such data in order to better understand and intervene in processes.

Elizabeth Teracino and Christine Legner then draw the attention to the trustworthiness of sustainability reports and metrics, which can be compromised by poor data quality and estimation reliability. Companies need to shift from reactive to proactive data sourcing to collect reliable, high-quality data not only within their own premises, but also externally, from suppliers, customers and third parties. Data sourcing involves a series of sense-making, data acquisition and reconciliation practices and represents a critical cornerstone of an enterprise-wide data strategy and data management approach that supports organizational sustainability transformation.

Felizia von Schweinitz and Laura Marie Edinger-Schons critically evaluate the prevalent impact valuation approach that quantifies sustainability impacts to translate them into monetary values. On the one hand, they point out that impact valuation is often said to offer significant opportunities in terms of reducing and comparing complex sustainability impacts, as well as enhancing business justifications for sustainability transformation. On the other hand, current impact valuation practices suffer from methodological issues such as aggregation and simplification that need to be collectively negotiated in order for the methods to have a real impact on internal steering.

Finally, Thomas Daniel Mardahl presents existing applications based on spend-based carbon reporting and reflects on the dark side of a data-driven approach to sustainability transformation. He emphasizes that environmental and financial reporting should go hand in hand to arrive at Green IS' potential for the impact on various sustainability dimensions.

2 Informational and Transformational Data Provision in Mandatory Sustainability Reporting

Karin Buhmann.

2.1 A Surge of Sustainability-Oriented Reporting Requirements

Recent years have seen a surge in public requirements on companies to disclose non-financial information on their environmental, social, and governance (ESG) impacts, policies and processes and/or corporate social responsibility (CSR). Being concerned with companies' societal impacts, these issues are closely related to sustainability. The general objective of regulatory non-financial reporting is that the reporting process should contribute to shaping company conduct to become more environmentally or socially sustainable (Hess 2019, 2008). That is particularly the case in regard to transnational business, because nation states are limited to regulating entities operating within their jurisdictions. However, they can make requirements on entities, such as companies, domiciled within their jurisdictions, also affecting value chains or other actions that connect to activities outside of those jurisdictions.

Non-financial reporting or disclosure is often considered to have originated in the United States with environmental reporting that emerged in the context of the National Environmental Policy Act (NEPA) regime. During the past decade, however, the EU has played a major role in regard to comprehensive ESG reporting requirements applying across the 27 EU member states. During that decade, two comprehensive ESG reporting acts have been adopted for EU companies, along with several other regulatory acts that require ESG data in investment contexts.

Adopted in 2014, the Non-financial Reporting Directive (NFRD) required large EU-based companies to disclose information on their CSR policies, implementation and results (EU 2014). The NFRD allowed for over-implementation, i.e. for countries wishing to do so to apply the requirements to a larger range of companies than those covered by the directive. In the coming years, the NFRD will be replaced by a somewhat more comprehensive EU law, the Corporate Sustainability Reporting Directive (CSRD) (EU 2022). The CSRD applies to a larger range of companies, although still mainly large ones. It introduces a double-materiality reporting focus. This means that information necessary to understand the impact of sustainability issues on the company should be reported, as well as information on the company's own impact on people and the environment. The former materiality focus fits the conventional approach to financial risk-management and inward-oriented, so-called 'transactional' due diligence, whereas the latter fits the outward-oriented, 'risk-based' societal due diligence approach. Originally conceived as an ongoing management process for companies to identify and handle their harmful impacts on society with a particular focus on human rights, risk-based due diligence has come to be expanded more widely to ESG issues (Buhmann 2021). This is also the approach found in the EU's Corporate Sustainability Due Diligence Directive, approved in 2024.

For CSRD reporting, the European Sustainability Reporting Standards (ESRS) specify detailed data that companies must report on their sustainability policies, practices and results. For environmental matters (E), the ESRS include issues related to climate change, water resources, circular economy, contamination, and biodiversity. For social matters (S), they include equal opportunities, employment matters, and respect for human rights. For corporate governance (G), they relate to the management's handling of corporate sustainability, business ethics and culture, as well as the company's control and risk management as to sustainability risks.

As this shows, the CSRD reporting requirements are very data-driven. In the wider context of this article, this leads the team of authors to suggest:

Proposition 1 *External non-financial reporting regulatory pressures lead companies to set up processes to collate and process data.*

However, disclosing a large amount of data may not appear to have much to do with regulation of company conduct, nor with pressure on companies to become more sustainable. The following section explains how sustainability reporting may drive organizational change.

2.2 Transformational and Informational Approaches as Drivers of Corporate Sustainability

Whether mandatory or voluntary, ESG reporting is generally viewed from one of two perspectives: an informational one, mainly concerned with providing investors and other stakeholders with data relevant to their decisions concerning the company; and a transformational one, targeting internal learning and focused organizational change (Eccles and Serafeim 2015). Like financial reporting, the informational approach to sustainability reporting

considers the report a source of valid information enabling stakeholders to monitor companies' ESG impacts and their efforts to manage adverse impacts.

As evident in the term, the transformational approach aims at spurring change with the company. Transformation is assumed to come about as a result of learning and other forms of reflection within the company's management (Buhmann 2020, 2013; Hess 2008). To stimulate such learning, the transformational approach allows for engagement not only with and from external stakeholders concerning the data, but also within the company. In fact, it almost assumes that some interaction takes place, either during the process of identifying the data to be reported, or in follow up. Learning may occur when managers process the data collated for reporting. For example, within the 'E' field, the data may indicate developments in the company's emission of environmentally harmful substances or CO2. Within the 'S' field, the data may indicate changes in occupational health and safety incidents, gender distribution among employees, or results of social audits with suppliers. Analyzing such data and comparing it, for example, to the preceding years may enable the management to identify steps that drive desired impacts within the company and in its interaction with the value chain. Such processing can allow the company's management to speedily act on the data, e.g. to bring down environmental emissions or to change practices to reduce health and safety incidents. Yet, transformation may also result from external pressure, and therefore also in response to data reported from an informational perspective. Investors or other external stakeholders may respond to disclosed data that they find to display unsatisfactory performance. For example, an investor may deploy the option to present shareholder resolutions, or a buyer may encourage a supplier to apply stronger occupational health and safety measures. Such a transformational effect will typically be delayed as compared to actions that the management may undertake in response to its own processing of data. On that basis, we may suggest:

Proposition 2 *Provision and data disclosure does not automatically lead to organizational learning.*

Reading the EU's CSRD as well as the NFRD, it is clear that the overall aim is transformational. This is evident from the preamble, i.e. the rather lengthy explanatory and policy part of the directive that precedes the binding part setting out reporting obligations that companies must comply with. The transformational objective is much less clear in the binding provisions. In terms of data, the NFRD required key-performance indicators (KPIs), the CSRD requires very detailed information aligned with the ESRS.

A study of the evolution of mandatory CSR reporting in Denmark during the decade 2008–2018 suggests that reporting can, indeed, stimulate transformation and organizational learning (Buhmann 2020). During this period, sustainability reporting in Denmark evolved from purely voluntary to a strongly transformation-oriented national CSR reporting requirement, and finally the information-oriented NFRD (with over-implementation to a large number of smaller companies). The study suggests that transformation is more likely when the reporting requirement is less data-oriented, for example in the sense of measurable KPIs, and more flexible, allowing companies to report on activities close to their specific sustainability-oriented activities and impacts. Moreover, it suggests that while transformation based on external pressure is possible, it cannot be assumed that disclosed information leads to external pressure by default. As several authors in this article show, data provision is frequently externally information-oriented and can become detached from core organizational functions. It will be important to follow whether organizational learning from the process of collating data for ESG disclosure under the CSRD will advance organizational learning and corporate sustainability, or whether the extensive data demands will mainly lead to increased information flows.

3 Sustainability Data as an Opportunity for Transformed Organizational Data Management

Tobias Brandt.

Organizations seeking to leverage data to foster a sustainability transformation will generally face the same obstacles that have been shown to impede data analytics projects in general during the past decade. One such major obstacle is represented by data silos, where critical data resources are fragmented across departments. The silo effect often not only restricts the accessibility of essential data sources but may also prevent stakeholders from even becoming aware of the different kinds of data collected within and about their organization. Even when data is available and accessible, it may be outdated or the data quality may be compromised due to, for instance, incomplete digitization efforts. Data silos are often a consequence of entrenched, complex organizational structures that may predate the digital era, making them particularly prevalent in large global corporations (Legner et al. 2020), traditional companies that have been operational for many decades (Gust et al. 2017), and public sector organizations (Gong and Li 2023; Zhang et al. 2022).

Hence, similar to broader organizational analytics initiatives, the long-term success of data-driven sustainability transformations is fundamentally dependent on organizations' ability to harness their data resources. At the same time, general analytics initiatives and those focusing on sustainability reporting differ in the degree to which they

are subject to external pressure. While governmental regulations forcing organizations to conduct predictive analytics on their unit sales are hard to find, the emergence and intensification of regulations related to sustainability reporting, such as the EU's CSRD, are hard to miss. For the BISE community, this institutional pressure raises multiple interesting propositions and related research questions concerning the interplay between sustainability reporting requirements and organizational data management.

Proposition 3 *Increasing sustainability reporting requirements have a positive impact on organizational data management.*

The proposition suggests that increasing sustainability reporting requirements improves organizational data management capabilities and practices in those organizations that were struggling with the same. The regulatory pressure may provide the necessary impetus to tackle existing data silos and fragmentation, pushing organizations to improve data quality and accessibility, creating a more unified data architecture that breaks down barriers between departments. If this can be observed, natural follow-up questions would investigate secondary effects of this improvement to data management, such as more efficient processes or a foundation to conduct business-focused analytics projects.

Proposition 4 *Effective organizational data management drives long-term success of sustainability transformation initiatives.*

While sustainability reporting requirements may push organizations to address data management issues, the second proposition suggests that achieving effective data management is instrumental in ensuring the long-term success of sustainability transformation ambitions. Clearly, sustainability reporting initially presents a burden to organizations, particularly if necessary data is inaccessible or incomplete. However, if the underlying data issues are not resolved, if every future report continues to be an amalgamation of piecemeal data collection, calls across various departments and functions, as well as manual integration efforts, this burden is never lifted. In contrast, if updated information on critical sustainability-related indicators is available at the literal push of a button, organizational stakeholders can invest their efforts into acting upon this information. Such a level of automation is, however, not possible without a well-organized data infrastructure and effective data management.

Proposition 5 *The reinforcing effect between sustainability reporting requirements, organizational data management, and sustainability transformation success will not be limited to those organizations subject to the reporting requirements.*

While based on, as of yet, anecdotal evidence, there are several theoretical arguments to be made on why the aforementioned phenomena would not be limited to organizations that are subjected to sustainability reporting requirements. During the past months and years, my group noted a growing interest in sustainability data and reporting by both unlisted small and medium sized companies and public sector organizations, neither of which are subject to CSRD requirements. Discussions with those organizations and theoretical considerations prompt several hypotheses on the drivers of that interest, namely:

- Companies anticipating a future expansion of the group of organizations with reporting obligations and seeking to be prepared for those situations;
- Smaller companies seeking to imitate market leaders (which are likely subject to CSRD); and
- Organizations responding to a growing awareness surrounding their sustainability impact within key stakeholder groups and broader society.

These drivers correspond to the notion of (anticipated) coercive, mimetic, and normative pressure respectively, emphasizing the role of institutional theory in explaining these potential spillover effects of sustainability reporting requirements (Butler 2011; Martínez-Ferrero and García-Sánchez 2017). At a methodological level, they also represent potential confounding effects that complicate the use of sustainability reporting obligations as explanatory variables in empirical models.

As a final note, while this contribution to the discussion paints the picture of data and data management being instrumental in ensuring the longevity and impact of sustainability transformation initiatives, they are by no means the only pieces to the puzzle. However, organizations are fundamentally driven by numbers, indicators, and measurements and I believe that Baskerville's (2008) reflections on measurements in academia and the IS community are just as fitting in the context of the long-term impact of sustainability transformations: What gets measured, gets done. What does not get measured, does not get done. What cannot be measured can only be managed indirectly. Effectively managed sustainability data may not be sufficient but is certainly necessary to *get things done*.

4 A Process Science Perspective on Sustainability

Jan vom Brocke.

The achievement of sustainability goals is essentially influenced by how we behave. In other words: Sustainability is delivered by processes and sustainability is a "function of processes" that unfold on many levels such as individual, group, organizational and market level (vom

Brocke et al. 2021a, b). Research has been investigating processes in regard to both sustainability objectives and results for over a decade (Seidel et al. 2013; vom Brocke et al. 2012), and it identified affordances of information technology to support sustainable processes and practicing, i.e. sensemaking affordances and sustainable practicing affordances.

While extant process research investigated abstractions of organizational behavior on type level, and famous examples include business process reengineering (Hammer and Champy 1993), process innovation (Davenport 1992) as well as enterprise systems (van der Aalst and van Hee 2003), process research today can analyze the execution of single processes (Franzoi et al. 2023; Hartl et al. 2023; Grisold et al. 2023). Based on digital trace data, and event log data in specific, process mining techniques allow to capture, visualize and analyze how processes actually run (van der Aalst et al. 2012) and what effects are caused by this (Badakhshan et al. 2022). The field of process science has emerged to leverage such computational capabilities and to integrate data from various sources to more comprehensively research and understand processes (vom Brocke et al. 2021a, b, 2024). We argue that such behavioral visibility affords new ways for sustainability research and practice, and we develop this position in three subsequent propositions.

Proposition 6 *By taking a process-oriented view on sustainability, we can look at the causation of sustainability results in specific contexts, thus, providing a basis for the development of more sustainable behavior.*

Process research has proven to support the design of processes in many ways, but so far mainly with a focus on metrics such as costs, quality and time. Henry Ford, for instance, has demonstrated how to dramatically increase productivity by analyzing and optimizing processes. By introducing factory-like processes it is reported he increased productivity from the production of 100 cars a month to 45 cars a day as opposed to the former craft-style processes, and scientific management has evolved (Taylor 1919).

With the growing awareness towards sustainability results, process research (and practice) has been further developed to expand its target system towards sustainability goals. The field of Green Business Process Management (Green BPM) has been established to inform organizations on how to design and manage their processes towards achieving better sustainability results (vom Brocke et al. 2012). Essentially, Green BPM aims at connecting both sustainability and process research. On the one hand, its key proposition is that only through process change, and the application of process-centered techniques, such as process analysis, process performance measurement, and process improvement, can the transformative power of IS be fully leveraged in order to create sustainable organizations (Seidel et al. 2013). In order to bring about such a change, it is proposed that process research must expand its value system beyond economic aspects to include the requirements of sustainability, in particular economic, ecological and social sustainability.

The body of knowledge in Green BPM discusses the different capability areas such as methods, IT, strategic alignment, governance, people and culture (Rosemann & Brocke 2015), and outlines how to further develop each capability in order to deliver sustainability objectives. It is also recognized to consider different organizational contexts as they provide opportunities and constraints for redesigning processes towards sustainability objectives (Zelt et al. 2019). Processes which are more bound to physical materiality and locations such as in heavy equipment manufacturing enterprises, for instance, place different requirements for sustainable process design (Neff et al. 2014) as opposed to processes that are naturally more open to flexible process design such as knowledge work (Davenport 2015).

Proposition 7 *Computational techniques such as process mining are available to analyze behavior and its effect on sustainability results based on digital trace data.*

More recently, process research has started to leverage the analysis of digital trace data, which represent recorded activities that are left behind when humans use digital technologies (Freelon 2014). Typically, digital traces are equipped with temporal information, allowing for insights on the activities carried out and the effects they take (Lazer et al. 2020). Furthermore, computational techniques, such as process mining, enable increasingly sophisticated analyses of such data (van der Aalst 2016), and today such technologies are widely available for practice (Grisold et al. 2021).

The field of process science provides methods to capture and integrate data from diverse sources, including environmental data, and to analyze such data in order to better understand and intervene into processes (vom Brocke et al. 2021a, b). Process science can provide a new foundation for sustainability research as it captures data on both the behavior in organizations and changes in the environment. Process science looks beyond conventional disciplinary boundaries, specifically capturing data from both owned and non-owned processes (Rescher 2000), and it specifically leverages digital trace data and computational methods to detect patterns in this data (vom Brocke et al. 2024).

The capability to trace processes on a single instance level as in process science provides a new lens to process and sustainability research. Particularly, process science allows to link individual behavior to specifically caused

sustainability results. Figure 1 illustrates the conceptual framework for such investigations.

The foundation for a process science approach to sustainability transformation is built by capturing sustainability relevant data from various sources. Such data is not limited to data from enterprise resource planning (ERP) Systems; it may well include sensor data e.g. capturing air quality, noise or stress as well as social data as captured e.g. through text analytics on social media platforms. Event log data is suitable for integrating data from such various sources, as relevant events can be recorded from all of them: e.g. a specific provider is commissioned, a specific communication channel used, a specific tool used, a certain amount of energy, a certain review received. Such data is then processed to (1) visualize sustainability in processes (description layer), (2) understand sustainability in processes (explanation layer), and (3) to support sustainable behavior in processes (prescription layer).

A recent project, for instance, investigated the case of a real estate management firm to promote sustainable practices in over 1000 student apartments, each equipped with smart metering technology, across two buildings in Berlin, Germany (Beermann et al. 2024). Aiming for a positive ESG initiative and reduce costs, data was collected on energy consumption and displayed to the users. The research sets out to understand students' sustainability behavior patterns. A relevant contextual factor in this study is that students are charged a flat rate, so understanding the mechanisms of how behavioral influences can be placed in the absence of monetary consequences is key. Research shows that visualising the sustainability impact of the students' lifestyle behaviour has a positive effect on their sustainability behaviour. Here, the manner of visualisation and feedback also plays a role in setting nudges for sustainable behavior based on process science data (Weinmann et al. 2016).

Proposition 8 *Process science allows capturing and analyzing sustainability data beyond organizational boundaries, particularly to integrate data from owned behavior and data from non-owned sustainability effects.*

Processes are owned when they involve agency and intention. Unowned processes occur without the intentions of any agent (Rescher 2000). When looking at real-world phenomena, both owned and unowned sociotechnical processes influence one another. Owned processes like production processes, influence unowned processes such as environmental developments. Vice versa, unowned processes have an impact on owned processes as shown dramatically by the Covid-19 pandemic.

Capturing data of both owned and non-owned processes at the same time allows us to analyze relations between both worlds, i.e. organizational practices and environmental developments. Process science investigates a processual phenomenon such as a city or a campus and may capture process data both from owned processes (e.g. mobility behavior) and non-owned-process (e.g. air condition). In this way, process science offers a new lens for sustainability research, which is to capture and record data from various sources that describe diverse aspects of behavior and sustainability effects. Analyzing this data, e.g. through computational methods, will help to see new relations and to better understand behavior in its effect on economic, environmental and social dimensions of sustainability. The aim is to enable people to make better decisions regarding sustainability, specifically to develop innovative solutions that incentivize and support more sustainable behaviour in alignment with the SDGs. However, such a data-driven approach to sustainability transformations presupposes the trustworthiness of the underlying data, which we will attend to in the next section.

5 The Lack of Trustworthiness in Sustainability Data: On Building Proactive Data Sourcing Practices

Christine Legner and Elizabeth Teracino

Halfway through the 2030 Agenda, the SDGs, 17 interlinked objectives that emphasize the interconnected environmental, social, and economic aspects of sustainable development (United Nations 2022), start to dripple down into organizing. Many companies have been using SDGs as a point of reference for their sustainability initiatives and actions, and more and more sustainability regulations and standards have appeared to help enforce these world goals in a more tangible manner, requiring more concrete actions and non-financial reporting from companies. Taking the European Commission's CSRD as an example, which comes into force in 2024, more than an estimated 50,000 companies are directly impacted by CSRD's mandatory reporting requirements. Organizations within those companies' global supply chains will also be indirectly impacted as all material and energy data flows from all value chains and product life cycles must be collected, analyzed, integrated, and verified.

5.1 How Trustworthy is Sustainability Data?

Proposition 9 *Low data quality and estimate reliability reduce trust in sustainability metrics and reports.*

Reporting on sustainability goals and complying with the many sustainability regulations and standards that become increasingly mandatory requires collecting, processing, and interpreting copious amounts of data which have not been systematically collected or analyzed previously, e.g., on emissions and material compositions. Even

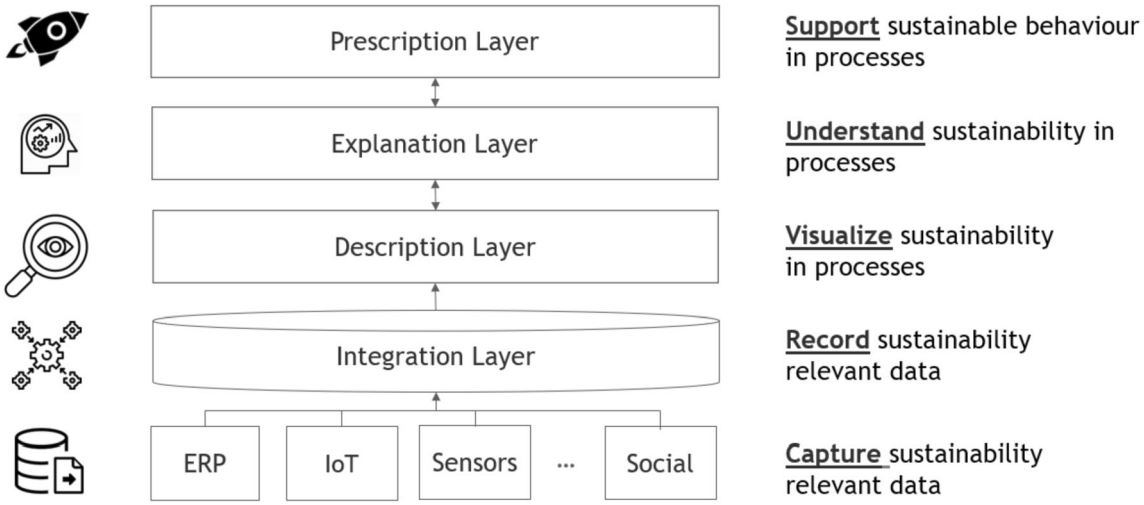

Fig. 1 Process science framework for sustainability (vom Brocke et al. 2024)

when data can be gathered, there is still a reliance on estimates, compromising the reliability of the calculated sustainability indicators and creating a lack of trust in the data and metrics. Such concerns have frequently resulted in allegations of "green-washing" and "label-shopping" (Szabo and Webster 2021). In 2021, the EU Commission found that 42% of reported sustainability claims were 'exaggerated, false or deceptive' with 59% of them lacking supportive evidence (European Commission 2021), while the United Kingdom's Competition and Markets Authority (Deloitte Development LLC 2021) echoed this finding where '40% of green claims could be misleading'.

Although Green IS literature has not explicitly addressed the data perspective on sustainability (Krasikov and Legner 2023), data-related problems have been frequently mentioned in sustainability studies, namely the unavailability of data (Machado Ribeiro et al. 2022; Watson et al. 2010; Zampou et al. 2022), the lack of data integration and consolidation (Marx Gómez and Teuteberg 2015; Zampou et al. 2022), and a lack of attention on data quality and its underlying dimensions, e.g. completeness and accuracy (Machado Ribeiro et al. 2022; Melville et al. 2017; Zampou et al. 2022). However, elaborations in the literature on how to address said issues, e.g., via data requirements, practices, or approaches, remain nascent.

5.2 From Reactive to Proactive Data Sourcing

Proposition 10 *When companies shift from reactive to proactive data sourcing, they are more effective in creating meaningful sustainability metrics and reports that act as catalysts for organizational sustainability transformation.*

Companies have typically reacted to each new sustainability challenge in an ad-hoc manner with more impromptu data sourcing practices, e.g., creating one-off non-financial reports or finding quick solutions to collect the required information for certificates or product labels (Teracino et al. 2024). However, this reactive approach does not scale and makes it difficult to respond to the increasing number of sustainability initiatives and to the dynamic regulatory landscape with specific data requirements and needs that often overlap and interact. Companies must become more proactive, by seeing the bigger picture, to identify the growing number of data requirements in the system as a whole and jointly approach them.

To fulfill these new data requirements and address major data quality challenges, to promote trust in the data and reporting, companies need to build processes and practices to collect reliable, high-quality data not only within their own premises, but also externally, from suppliers, customers and third parties. Drawing attention to the data perspective in this context, a spotlight must be put on data sourcing, defined as '…procuring, licensing, and accessing data (e.g., an ongoing service or one-off project) from an internal or external entity (supplier)' (Jarvenpaa and Markus 2020, p. 65). Data sourcing practices need to go beyond data hoarding and, instead, must involve a series of sensemaking, data acquisition and reconciliation practices (Krasikov and Legner 2023). Sensemaking entails a systematic and sophisticated analysis of sustainability goals, initiatives, and regulations, with the aim of translating these into tangible data requirements (Butler 2011; Krasikov and Legner 2023; Teracino et al. 2024). Here, necessary data objects and attributes are identified as those which must be collected. This practice additionally requires organizational adjustments, e.g., the definition of organizational roles and responsibilities needed for sustainability data. Data collection follows, with the aim of obtaining the data needed for the sustainability initiatives.

Internal data is often located within existing operational systems (e.g., ERP or PLM systems); however, it usually must be amended for the intended purpose of use. Data that cannot be collected internally must be found externally, e.g., from suppliers in the case of value chain-related endeavors. Data reconciliation is finally necessary to prepare the data for further manipulation, for example KPI calculations, and this involves harmonizing data obtained from different (internal and external) sources, with varying data types and formats, and aggregating it to match the level of granularity required. Although proactively building data sourcing practices is a logical place to start, these also impact the existing structures they are embedded in and, thus, need to simultaneously be supported and enabled by them.

5.3 Data Sourcing Relies on Cross-Functional and Inter-Organizational Collaboration

Proposition 11 *Without cross-functional collaboration within and across enterprises, companies will not be able to establish comprehensive reporting and monitoring of their sustainability initiatives.*

Data sourcing practices rely on the cross-functional collaboration of multiple stakeholders within an enterprise and new roles must be considered and defined. For instance, sustainability and compliance officers and business analysts must work together for sensemaking; data stewards and analysts as well as business operatives for data collection; and data stewards and engineers for data reconciliation. Sourcing extends beyond organizational limits for sustainability, so people, roles and processes must also be considered externally, such as through suppliers, logistics providers and other partners along supply chains. With more heterogeneous and, sometimes, unstructured data collected from various (internal and external) sources, these must be standardized and integrated within internal systems and adapted for the new data and business requirements. Therefore, establishing intelligent data collection approaches and proactively readying existing data applications and architectures are paramount for supporting data sourcing practices for sustainability. Data reconciliation requires companies to develop standardization and integration strategies that ensure seamless information flows and effective analytics that can reach all areas of an organization.

For future research, Green IS and sustainability researchers must, therefore, develop a more holistic perspective on sourcing sustainability data that takes into consideration both collection and interpretation of data that has not been previously collected or reused. Building up data capabilities surrounding sensemaking and the provision of sustainability data and metrics (e.g., enriched data sets, KPIs, dashboard, benchmarks) support the grander, board-level sustainability initiatives and make these goals achievable. These capabilities are a critical cornerstone of an enterprise-wide data strategy and data management approach that supports organizational sustainable transformation.

6 Meaningful Metrics? Issues and Remedies in Corporate Impact Measurement

Felizia von Schweinitz and Laura Marie Edinger-Schons.

6.1 Sustainability Challenges and Impact Measurement

Pressing sustainability issues such as climate change and biodiversity loss pose essential coordination and cooperation challenges to humanity. In light of the growing public awareness of the urgency to act, companies themselves increasingly recognize their responsibility (Carroll 1979; Porter and Kramer 2011), visible in corporate communication, such as higher purpose statements and the efforts among practitioners to measure their impacts on stakeholders (Braig and Edinger-Schons 2020; Carroll 1979; Hadad and Găucă 2014; Saebi et al. 2019). Impact measurement typically includes measuring outcomes in terms of effects on individuals, and impact as societal-level achievements (Ebrahim and Rangan 2014). To grasp the underlying impact logics, logic models such as the "IOOI model" (i.e., input, output, outcome, impact) are commonly applied. They illustrate how corporate inputs produce countable outputs, leading to outcomes for improved sustainability, and eventually impact on the society. For instance, inputs like funds and labor could be used to organize a certain number of employee trainings (outputs), leading to increases in participants' skills and perceived self-efficacy and wellbeing (outcomes), contributing to SDG 3 – Good Health and Wellbeing. On a societal level, this may imply an increased quality of life in a community. Such rigorous impact measurement enables companies to steer organizational and strategic alignment, improve their impact orientation, stakeholder orientation, and legitimization, and may subsequently allow them to gain better access to funding (Braig and Edinger-Schons 2020; Stroehle et al. 2022).

6.2 Challenges in Impact Measurement

Growing corporate awareness is accompanied by regulatory pressure (e.g., CSRD on European level) and the evolving field of ESG data which present a growing market for rating agencies, assurances, and consultancies.

Simultaneously, management scholars have pointed to various weaknesses of ESG data, such as limited data availability, accuracy, and consistency (Berg et al. 2022; Busch et al. 2022; Chatterji et al. 2016; Drempetic et al. 2020), correctly capturing additionality and causality of impact through quantitative and aggregated data (Busch et al. 2023; Ebrahim and Rangan 2014; Ketter et al. 2023; Rawhouser et al. 2019; Schlütter et al. 2023), and subjectivity. This refers to the fact that sustainability data is subject to organizational sensemaking (Seidel et al. 2013) and translated into practice through technological, organizational, and sociotechnical actions (Parmiggiani et al. 2022).

6.3 Toward Data-for-Transformation

It thus remains questionable whether current ESG data is rather data-for-compliance with a short-term focus, or whether it illustrates the complete scope of long-term company impact. For instance, ESG indicators on reforestation may capture the number of projects supported, or trees planted, but whether those thrive in an ecosystem and can support future ecosystem restoration and climate change mitigation remains to be observed in the long run. This similarly applies to indicators on employee development: long-lasting effects of educational interventions may only manifest after a longer period of time, i.e., once it becomes evident to what extent the intervention has fostered skill building, and whether this eventually results in higher job security or a higher living standard at a later point in an employee's life. Long-term oriented data must therefore be accompanied with foresighted management. In order to transmit meaningful information about social and planetary welfare, impact data should provide a holistic picture of company impact in the sense of data-for-transformation towards a more sustainable way of doing business. In order to adhere to this, the selection of metrics to capture corporate inputs needed to produce outputs, outcomes, or impacts should be aligned with a company's motives, i.e., its purpose, mission, vision, and values. In a further step, monetization approaches may be applied that rely on enterprise cost-based accounting or societal valuation approaches (Barby et al. 2021). For instance, social enterprises like Social Bee aim to integrate refugees into the job market while transparently measuring their impacts. Their approach involves quantifying both output (i.e., number of refugees integrated) and outcome (e.g., enhanced well-being and reduced stereotypes) levels and, where appropriate, assigning monetary values to impacts, such as calculating how much tax money is saved through successful refugee integration. This forms the foundation for innovative funding models like impact bonds and impact investing. We thus adopt the definition of impact measurement and valuation (IMV) that describes it as "an approach that is built on the idea that value creation is mutually dependent. It is a set of tools and methodologies that enable companies to identify, measure, monetarize, and manage their societal and environmental impacts" (Braig and Edinger-Schons 2020).

6.4 Addressing Challenges in Impact Measurement and Valuation

Measuring and especially expressing impacts in monetary values enables managers to compare them translated to the language of business and, thus, act upon them. In this article, we address crucial conceptual, methodological, and ethical challenges of this practice and propose to reconsider the ways we measure sustainability impact. We contribute by proposing potential remedies for prevailing issues that can inform IS and interdisciplinary research on IMV and pursue a focus on data-for-transformation.

A salient issue in the field of IMV are methodologies developed by practitioners which lack scientific rigor and transparency. Method development has often been led by Big Four accounting firms or consultants and has not undergone peer review processes. Company networks such as the Value Balancing Alliance make use of such methods to translate impacts into monetary metrics and to sometimes even net negative impacts with positive impacts, communicating a "net positive" narrative. In these calculations, countable outputs are merely multiplied with valuation coefficients and communicated as "impact" while they, in fact, completely omit measuring outcomes, thus not holistically capturing impacts. Current methods may not adequately reflect causal inferences since they primarily rely on aggregation of impact (Busch et al. 2023; Ebrahim and Rangan 2014; Ketter et al. 2023; Rawhouser et al. 2019) while, in reality, impact is complex and only unfolds over time via outcomes. Thus, criticism emerges among IS, accounting, nonprofit management, social entrepreneurship, and other scholars (Braig and Edinger-Schons 2020; Ebrahim and Rangan 2014; Ketter et al. 2023; Ormiston and Seymour 2011; Stroehle et al. 2022). To ensure valid IMV methodologies, we need rigorous IMV method development which is subject to a thorough scientific peer review. To tackle the lack of transparency in IMV (Berg et al. 2022; Rawhouser et al. 2019), it would be helpful to use principles of open science to foster transparent communication on employed data, the measurement process, and the underlying calculations in the processes of aggregation and valuation of impacts.

Proposition 12 *Rigorous methodology development, peer review, and transparency are essential for impact measurement and valuation to unfold its potential.*

The practitioner-led method development raises concerns of corporate self-regulation (Braig and Edinger-Schons 2020) and should therefore be encountered by comprehensive and continuous stakeholder engagement efforts to enable stakeholders to participate in IMV decisions, fostering legitimacy and information democratization (Seidel et al. 2013). In this regard, solid governance mechanisms have to be implemented to ensure critical reflection and continuous development of methodologies. Otherwise, IMV could be regarded as a new form of colonialism, as it affects all stakeholders of corporate actions around the world, but is exclusively developed by an expert corporate elite from the global north.

Proposition 13 *Comprehensive stakeholder engagement is needed to foster information democratization and legitimacy in impact measurement and valuation.*

Various understandings of the concept and measurement of impact exist (Berg et al. 2022; Chatterji et al. 2016) and scholars observe the lack of a common currency in IMV (Alomoto et al. 2022; Kah and Akenroye 2020; Rawhouser et al. 2019). With regard to standardization, we however suggest preventing premature standardization of specific methods, allowing for distributed experimentation as suggested by Ferraro et al. (2015) in response to tackling grand challenges. Research has shown that experimentation can be helpful in this regard (Schlütter et al. 2023), and that so-called "meta standardization", i.e., standardization at a more abstract level has proven to be effective in other areas, e.g., sustainability certification standards in the coffee industry (Reinecke et al. 2012).

We further recommend providing disaggregated sustainability data and being very cautious of when and how to use aggregation. Aggregation in the form of "netting", as sometimes practiced by firms, may mask important information and lead to accusations of greenwashing. A mixed-method measurement design may be suitable as well to more precisely capture changes in societal and planetary well-being and provide data-for-transformation.

In fact, Ferraro et al. (2015) underline that in order to capture grand challenges, which are inherently complex, solutions to manage them need to be complex as well. Thus, managers need to be able to manage this complexity. Navigating between adequately representing the complexity of sustainability challenges and of measuring impact in IMV methods while keeping them practicable pushes managers to engage in tradeoff decisions. We suggest that there may be a "sweet spot" of complexity reduction which may lie between the very disaggregated list of hundreds of indicators, and the "one number for impact" which many practitioners and politicians are striving for.

Proposition 14 *Negotiating an optimal level of complexity reduction in impact measurement and valuation methodologies – including the provision of disaggregated sustainability data, avoidance of netting positive and negative impacts, and using mixed methods approaches – can help to find the "sweet spot" of complexity reduction.*

Furthermore, the ability of IMV to capture impact as holistically as possible may require assessment beyond the ESG tripartition. While we argue that such a "sweet spot" is useful, we suggest that it would have to be collectively negotiated by relevant stakeholders. In this negotiation, it is pivotal to prevent the risk of "taboo-tradeoffs" (Tetlock and McGraw 2005) between previously socially governed norms that are now quantified and subject to market logics (Satz 2012). Beyond the question of how we measure and to which degree complexity should be reduced in measurement, discussions on what these metrics should be used for are necessary. Due to their potential for greenwashing and stakeholder deception, monetary metrics of impact valuation should only be used for internal steering and, if necessary for external communications with e.g., expert stakeholders like impact investors. What should be prevented is an unreflected large-scale use of impact valuation as a tool to tell a "net positive" story.

7 A Practitioner Perspective: Spend-Based versus Activity-Based Carbon Reporting

Thomas Daniel Mardahl

Many companies currently rely on spend-based carbon reporting, a method that calculates a company's environmental impact based on financial expenditure for materials, energy, and waste. Seemingly straightforward, spend-based carbon reporting suffers from several key limitations, especially related to the representation of a company's sustainability efforts and the actual environmental impact of their products and services. For instance, purchasing a more energy-efficient product with a higher upfront cost might appear to increase the company's carbon footprint – simply because it represents a higher expenditure following the logic of spend-based reporting. In this sense, spend-based reporting can lead to counterintuitive results despite the company's sustainability efforts. This may disincentivize companies from making sustainable choices that have higher initial costs. In addition, spend-based reporting may also fail to capture the impact throughout the entire life cycle of a product or service, from material sourcing, production, use to disposal. This lack of granularity further hinders companies from pinpointing areas for improvement and implementing targeted sustainability strategies.

As a response, activity-based reporting (ABR) emerges as a more comprehensive, data-driven alternative to address the shortcomings of spend-based methods in measuring carbon emissions. I argue that the transition from spend-based to activity-based carbon reporting represents a significant paradigm shift in measuring a company's carbon emission and requires scrutiny of its actual effects and implementation.

7.1 Activity-Based Reporting: A More Comprehensive Approach to Environmental Impact Measurement

ABR assigns carbon emissions based on specific activities within a product or service's lifecycle. Imagine a smartphone. Using spend-based reporting, the entire carbon footprint might be attributed to the purchase price. ABR, by contrast, would consider the carbon emissions of material extraction, manufacturing processes, energy consumption during use, and end-of-life disposal in producing the smartphone. This granular level of detail is key to understanding a product or a service's actual environmental footprint and is specific to how these products and services are produced by each company. Life Cycle Assessment data especially plays a crucial role in providing such details by quantifying the carbon emissions of a product or service throughout its lifecycle. In this sense, when integrated with the life cycle assessment of a company's product or service, ABR enables companies to develop a more precise picture of their environmental impacts across the value chain. ABR can also provide a more comprehensive assessment of sustainability performance and potentially inform decision-making regarding activities that promote sustainability.

Proposition 15 *Activity-based reporting can provide a more comprehensive picture of a company's sustainability performance throughout a product or service's lifecycle.*

7.2 Activity-Based Reporting: Data Challenges

While ABR holds immense potential, several significant data challenges need to be addressed in order to facilitate a smooth transition from spend-based to activity-based reporting. For complex products or services, like those in the IT sector with numerous components and intricate supply chains, the data volume required for comprehensive ABR can be immense. An example of this challenge is the European Patent Office, which has over 65,000 different IT products. To manually conduct life cycle assessment on these IT products is impractical. Today, there are specialized companies who leverage automated data collection and analysis techniques to provide the necessary data and expertise for creating a comprehensive picture of a product's environmental impact, but their effects remain to be tested and their actual implementation requires further exploration in relation to the following areas:

1) Data standardization. Standardization of environmental impact data formats and metrics across industries is crucial for effective data sharing and analysis. This standardization would enable consistent comparisons and benchmarks. Therefore, research efforts focused on developing standardized data collection and reporting protocols are essential.
2) Data collection and processing techniques. Developing sustainable and effective methods for automated data collection and processing is critical. This includes exploring technologies like big data analytics, artificial intelligence, and machine learning to streamline data management and analysis.
3) Industry-specific guidelines. Developing industry-specific guidelines for ABR implementation would provide orientations for companies across various sectors. These guidelines could offer tailored recommendations for data collection, analysis, and reporting based on specific industry challenges and opportunities.

Proposition 16 *Further research on data standardization, automated data processing techniques, and industry-specific guidelines will be key to solving challenges in data volume and processing, unlocking the full potential of activity-based reporting and accelerating organizations' sustainability transformation.*

7.3 Financial and Carbon Accounting Convergence: A Holistic View for Sustainability Transformation

An organization's journey towards sustainability requires not just environmental awareness but also a clear understanding of its financial implications. In practice, this requires financial and carbon accounting convergence that involves integrating data from both financial and carbon accounting systems. Such convergence offers a holistic perspective on a company's performance and strategy-making that considers both financial viability and environmental impact. More specifically, by considering both financial and environmental factors, and integrating financial and carbon reporting, companies can potentially achieve sustainability transformation through:

1) Improved decision-making. Integrating financial and carbon reporting can enable more informed decision-making that prioritizes long-term sustainability without sacrificing financial viability. For instance, carbon-corrected costs offer a practical example. This approach allows a company to assign a cost to a

ton of CO2eq and to incorporate this cost in product pricing.

2) Strategic resource allocation. A holistic view allows for strategic resource allocation, directing investments towards initiatives that optimize both financial and environmental performance.
3) Enhanced risk management. Understanding the environmental impact alongside financial risks allows companies to proactively manage potential environmental liabilities.

Proposition 17 *Financial and carbon accounting convergence can drive an organization's sustainability transformation by enabling more informed decision-making, optimized resource allocation, and enhanced risk management.*

Overall, it is instrumental that companies take a comprehensive approach to measuring environmental impact. On the one hand, automated data analysis may offer solutions. On the other hand, these digital solutions might also have a negative environmental impact that should be taken into account when choosing a technology for sustainability reporting.

8 Conclusion

Lea Püchel and Cancan Wang

This discussion paper commenced by inquiring what needs to be done to unleash the full potential of data for the sustainability transformation. Each section subsequently provided propositions that serve as a roadmap for exploring how data management approaches can be optimized to support sustainable development goals. Overall, this discussion provides a frame of reference for research, for example for sustainability reporting approaches (i.e., regulatory non-financial reporting and carbon-reporting approaches), impact measurement and valuation method, and data activities (i.e., data management, data processes and data sourcing). This will allow Information Systems scholars some guidance in approaching the role of data in the sustainability transformation. We argue that it is important to consider the choice of different sustainability reporting approaches and their alignment with the choice of impact measurement and valuation method as well as data strategies and practices, when tackling corporate sustainability transformation,. We call for future IS research to explore the connection between these dimensions and how the interplay of the reporting approaches, impact measurement and valuation method, and data activities shape corporate sustainability transformation, in the truest sense of the word.

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