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# Introducing a Data Perspective to Sustainability: How Companies Develop Data Sourcing Practices for Sustainability Initiatives

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**Abstract:**

Many companies use the UN Sustainable Development Goals as a point of reference for their sustainability initiatives and actions. Reporting on these goals requires collecting, processing, and interpreting substantial amounts of data (e.g., on emissions or recycled materials) that were previously neither captured nor analyzed. Although prior studies have occasionally highlighted the issues of data availability, data access, and data quality, a research void prevails on the data perspective in the sustainability context. This article aims at developing this perspective by shedding light on data sourcing practices for the reliable reporting of sustainability initiatives and goals. We make a two-fold contribution to sustainability and Green IS research: First, as a theoretical contribution, we propose a framework based on institutional theory to explain how companies develop their data sourcing practices in response to regulatory, normative, and cultural-cognitive pressures. Second, our empirical contributions include insights into five case studies that represent key initiatives in the field of environmental sustainability that touch on, first, understanding the ecological footprint, and, second, obtaining labels or complying with regulations, both on product and packaging levels. Based on five case studies, we identify three data sourcing practices: sense-making, data collection, and data reconciliation. Thereby, our research lays the foundation for an academic conceptualization of data sourcing in the context of sustainability.

**Keywords:** Data Sourcing, Sustainability Reporting, Institutional Theory, Data Quality, Sustainable Development Goals, Triple Bottom Line.

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# 1 Introduction

The year 2015 marked the appearance of the United Nations (UN) General Assembly's agenda to ensure a more sustainable future by 2030 through Sustainable Development Goals (SDGs): a collection of 17 interlinked objectives that emphasize the interconnected environmental, social, and economic aspects of sustainable development (United Nations, 2022). Since then, sustainability objectives have become a priority of the public and private sectors worldwide. The SDGs are widely used as a reference point, even though their operationalization and implementation at the local level – referred to as "localization" (Tremblay et al., 2021) – remains challenging. Many organizations work on mapping the SDGs into their own initiatives and actions (Corbett & Mellouli, 2017; Pan et al., 2022; Tremblay et al., 2021) and integrating them into their annual reports, emphasizing the importance of a holistic view on economic profit, as well as social and environmental impact, also known as the 'triple bottom line' (Milne & Gray, 2013). In general, sustainability reporting has significantly evolved over the past decades. Whereas standard formats for sustainability reporting lacked in the past (Melville, 2010), much progress has since been made due to the introduction of mandatory sustainability regulations (Christensen et al., 2021) within the frameworks of, among others, the Global Reporting Initiative (GRI) (GRI, 2022), the European Union (EU)'s (2014) Non-Financial Reporting Directive (NFRD) and its recently published expansion with the Corporate Sustainability Reporting Directive (CSRD) (Official Journal of the European Union, 2022), and the European Green Deal (European Commission, 2022).

Although the sustainability reporting structure and requirements are much clearer at present, data availability, data access and data quality have emerged as the main issues (Deloitte, 2021; EDM Council, 2022; Stoll, 2022). In reality, reporting on sustainability goals requires collecting, processing, and interpreting large amounts of data, especially on emissions and product composition, which have not been systematically collected or analyzed previously. Even when organizations can gather the required data, they often have to rely on estimates and also lack details about its provenance. This drawback not only compromises the reliability of the calculated sustainability indicators but also raises concerns about greenwashing (Szabo & Webster, 2021). For instance, the European Commission (2021) contends that 42% of analyzed green claims were "exaggerated, false or deceptive" with 59% of them lacking supportive evidence, while the United Kingdom's Competition and Markets Authority (2021) states that "40% of green claims could be misleading." Without commonly accepted definitions and standards, it is difficult to collect and compare data on sustainability initiatives within and across organizations; an aspect that has only been discussed within the scope of larger public initiatives, for example, in agriculture (Vrolijk et al., 2016) and in the European open data plan for the collection of geospatial, earth observation, or mobility data (Nuthi, 2022), but remains to be addressed in the enterprise context.

Despite the data's relevance for reliable reporting on sustainability initiatives and goals, there is a void of research on the data perspective in the context of sustainability. This also applies to Green IS (Pan et al., 2022; Seidel et al., 2017; Watson et al., 2010) and more specifically to environmental management information systems (EMIS), which are supposed to play a significant role in "structured and goal-oriented data gathering, administration, integration, and processing" (Stindt et al., 2014, p. 2) of environmental information. Although certain authors highlight data availability and data quality as key issues in EMIS (Melville et al., 2017; Zampou et al., 2022), the existing studies focus on EMIS design, in terms of components, features and design principles. Although they mention data quality as a key concern, they hardly elaborate on the data requirements for EMIS and only give minimal attention to data accessibility for sustainable development (Machado Ribeiro et al., 2022). These data-related problems become particularly urgent when reporting on sustainability initiatives becomes mandatory and requires the audit of the reported information, as imposed under the CSRD (Official Journal of the European Union, 2022). To fulfill these requirements and ensure trustworthy sustainability reporting, companies need to build processes and practices to collect reliable, high-quality data not only within their own premises but also externally, for instance, from suppliers.

Our study is a first step toward the development of a data perspective on sustainability and draws attention to data sourcing, which is defined as "procuring, licensing, and accessing data (e.g., an ongoing service or one-off project) from an internal or external entity (supplier)" (Jarvenpaa & Markus, 2020, p. 65). Institutional theory has been widely used in management and sustainability literature (Butler, 2011; Glover et al., 2014; Wang et al., 2015) to study the management practices that enterprises have developed to address regulative, normative, and cultural-cognitive pressures in their environment. Thus, assuming that pressures have an undeniable impact within the sustainability context (Daddi et al., 2020), institutional

theory provides a useful lens to study the emerging data sourcing practices in sustainability initiatives and to address the following research question:

**RQ: How do companies develop data sourcing practices in response to institutional pressures in the sustainability context?**

In our study, we leveraged qualitative research methods, including focus groups and case studies, which are "well-suited to capturing the knowledge of practitioners and developing theories from it" (Benbasat et al., 1987, p. 370). Our research setting is a multiyear research program studying data management practices for sustainability, which provides us with privileged access to data experts representing 12 multinational companies. These multinational firms are experiencing a wide range of institutional pressures and, in turn, report on their sustainability initiatives as part of their annual statements or in special corporate sustainability reports. For the case analysis, we selected the five most mature firms (of the 12) and analyzed their key sustainability initiatives and data sourcing practices through the prism of institutional theory. This approach enables us to identify causal chains leading from the relevant pressures to the resulting sustainability initiatives and to identify emerging data sourcing practices.

Our findings are a first step towards the development of a data perspective on sustainability and Green IS research. Our findings make a two-fold contribution. First, as a theoretical contribution, we propose a framework based on institutional theory to explain how companies – in the sustainability context – develop their data sourcing practices in response to exerted pressures. Second, our empirical contributions include insights into five case studies that represent key initiatives in the field of environmental sustainability that touch on understanding the ecological footprint and obtaining labels or complying with regulations, both on product and packaging levels. We derive three general data sourcing practices – sense-making, data collection, and reconciliation – which pave the way for reliable and trustworthy sustainability reporting. Our study exemplifies impact-oriented Green IS research (Gholami et al., 2016), guiding enterprises on their way to becoming more sustainable by embedding sustainability in IS and in practice (Seidel et al., 2017).

The remainder of the paper is structured as follows: Section 2 introduces institutional theory to study how companies adapt their management practices in the context of sustainability. By reviewing prior literature related to SDGs, sustainability reporting and Green IS, this section identifies and justifies the missing data (sourcing) perspective as a research gap. Section 3 elaborates on our qualitative research design and the three phases of the research process. Section 4 synthesizes our research framework and the collected insights about product- and packaging-related initiatives, while section 5 generalizes our findings in the form of the three categories of data sourcing practices for sustainability. In section 6, we discuss our findings, derive implications for research and practice, and outline the limitations and actions needed to address them.

# 2 Background

## 2.1 Sustainability from the Perspective of Institutional Theory

The 2030 Agenda for Sustainable Development, adopted by all UN Member States in 2015, has made sustainability a high-priority, strategic topic for most organizations. At its heart are the 17 SDGs "which are an urgent call for action by all countries – developed and developing – in a global partnership" (United Nations, 2022), with overarching objectives to end poverty, improve health and education, reduce inequalities, and tackle climate change. Since 2015, enterprises have adopted the SDGs as a holistic framework to organize their own activities and clearly communicate their actions to the general public (Galleli et al., 2021). Prior research has shown that "institutional pressures influence organizations to address the Sustainable Development Goals" (Galleli et al., 2021, p. 5). These institutional pressures come from the environment and, more specifically, from the enterprises' customers, their competitors, and the increasing number of regulations that impact the prioritization of SDGs and sustainability initiatives (Galleli et al., 2021; Lu et al., 2018; Yang, 2018). According to institutional theory, which has been widely used in management and sustainability literature (Butler, 2011; Glover et al., 2014; Wang et al., 2015), organizations adapt their practices in response to a range of regulative, normative, and cultural-cognitive pressures in the environment. The theory argues that the resulting pressures, as perceived, incite enterprises to conform to institutional expectations (DiMaggio & Powell, 1983) since any violation thereof could jeopardize organizational performance and long-term development (Teo et al., 2003). DiMaggio & Powell (1983) discuss three types of institutional pressures (i.e., coercive, normative, and mimetic) that delimit and shape organizational actions. Building on the work of the early institutionalists, recognizing the

multidisciplinary nature of the field, and connecting theory with empirical research, Scott (2013) conceptualizes “three pillars” that encapsulate regulative, normative, and cognitive pressures, which respectively relate to legally mandated behavior, behavior guided by moral norms, and commonly understood behavior. Organizations tend to adopt comparable practices and structures to establish their place and gain legitimacy within their respective industry (Scott, 2013).

Applied to sustainability, **regulative** pressures (also referred to as coercive or legislative pressures) originate from political influence and governmental agencies and result in legally imposed rules, laws, or sanctions. In this regard, sustainability regulations are among the major sources of external influences that drive environmental management practices (Butler, 2011; Yang, 2018). They are typically delivered to enterprises in the form of environmental conventions/directives, for example, the EU’s NFRD (Official Journal of the European Union, 2014) which all 28 EU members have adopted and incorporated in their respective national laws. **Normative** pressures imply that companies go beyond the legal requirements and adopt new practices which conform to societal norms and values (Scott, 2013). In the context of sustainability, this is reflected in pressures exerted by customers. For instance, consumers’ awareness of the ecological, social, and economic consequences of their consumption drives the increase in their demands for more sustainable products (Lu et al., 2018). Enterprises, in turn, react to the changing demand by improving their supply chain practices (Lu et al., 2018; Yang, 2018). Finally, **cultural-cognitive** pressures (also known as mimetic pressures) are mainly driven by uncertainty and enterprises’ ambiguity when stimulated by the environment (Scott, 2013). From the sustainability perspective, competitors’ actions create precedents that prompt other enterprises to improve and mimic their environmental activities, among others, by reducing pollution and building a corporate green image (Yang, 2018). Another instance of a cultural-cognitive influence on enterprises is exemplified by The Carbon Disclosure Project, which motivates organizations to voluntarily evaluate and disclose their carbon dioxide emissions as well as their mitigation strategies to reduce the effects of climate change and to improve their corporate image (Butler, 2011; Melville, 2010).

These three types of institutional pressures and their influence on management practices are studied in both sustainability and Green IS research. For instance, Raj et al (2020) identify and discuss public procurement practices in different business contexts (e.g., sustainable supply chain, product modularity, environmental innovation). Butler (2011) uses the foundations of institutional theory to reflect on the implementation of a specific Green IS, the Compliance-to-Product application, as well as on its ability to support sense-making, decision-making, and knowledge sharing or knowledge creation. To conclude, institutional theory provides a widely accepted framework to study how enterprises adapt management practices, including the practices that drive SDG implementation and sustainability reporting.

### 2.2 SDG Implementation and Sustainability Reporting

Although enterprises have made major efforts to address the 17 SDGs, reporting on these efforts is not without its challenges, and practitioner reports highlight data quality among the key concerns (Deloitte, 2021; EDM Council, 2022; Stoll, 2022). Most large enterprises do use the SDGs as a guiding framework to build a compelling narrative that conveys their achievements through corporate sustainability reports, but struggle to actually report on the SDGs, with any real clarity. Despite the existence of SDG targets, which elaborate on the specific objectives of overarching SDGs, they face difficulties in operationalizing and mapping them to their own initiatives (Corbett & Mellouli, 2017; Pan et al., 2022; Tremblay et al., 2021). An interesting approach was adopted by Bissinger et al. (2020) who analyzed 232 voluntary sustainability standards (VSS) with more than 800 requirements, mapping them – in the process – to 16 (of the 17) SDGs. This empirical study was one of the first attempts to better understand how diverse standards contribute to the SDGs. However, the authors’ findings revealed that a single standard could span multiple SDGs and could induce multiple overlaps, thus pointing toward a clear need to develop suitable KPIs and frameworks, developing synergies between the goals of the VSS and the UN.

While literature on SDG implementation and reporting remains scarce, sustainability reporting, in general, has been widely discussed. Originating largely from the triple bottom line framework (Milne & Gray, 2013), the aim of sustainability reporting is to obtain, process, and disseminate information (qualitative and quantitative) about an organization’s success in three key areas: financial performance, impact on the environment and on people (Marx Gómez & Teuteberg, 2015; Seethamraju & Frost, 2016). "Triple-bottom-line reporting, also known as sustainability reporting, involves reporting nonfinancial and financial information to a broader set of stakeholders rather than just the shareholders" (Ivan, 2009, p. 108). Sustainability reporting has evolved over the past decades, transcending traditional financial reporting (Sisaye, 2021), under the influence of clearer sustainable development goals and new reporting

regulations (Christensen et al., 2021), particularly the GRI (GRI, 2022), the EU's NFRD (Official Journal of the European Union, 2014), and the European Green Deal (European Commission, 2022). The GRI provides clear guidelines on integrated reporting and much-needed metrics and has been adopted on a large scale. Since its introduction, more than 10,000 companies – covering more than 100 countries and including 73% of the world's 250 largest firms – voluntarily chose the GRI (Christensen et al., 2021; GRI, 2022).

As sustainability and financial reporting are intrinsically linked (Sisaye, 2021), sustainability reporting initiatives within organizations are oftentimes driven by accounting and finance departments. Emerging in the context of traditional reporting (Sisaye, 2021), sustainability reporting stemmed as a standalone type with direct implications for reporting service providers (e.g., consulting and audit firms). Furthermore, reporting is largely led by advisory institutions (e.g., the World Resources Institute and the United Nations Conference on Trade and Development) or by professional accountancy bodies (e.g., the Federation of Accountants, the Federation of European Accountants, Deloitte, KPMG, PWC, and Ernst & Young) (Seethamraju & Frost, 2016). In addition, environmental and social concerns of Corporate Social Reporting (oftentimes directly associated with sustainability reporting) go hand-in-hand with financial reporting and are associated with a competitive edge and improvements in financial performance (Sisaye, 2021). Hence, financial reporting integrates sustainability information to identify financial risks or opportunities related to the impact of the reporting entity's activities and, in turn, reports on enterprises' assets, liabilities, equity, and expenses.

### 2.3 The Missing Data Perspective in Green IS

Sustainability initiatives and adjoining reporting rely on qualitative and quantitative information about the company's actions. To this end, "some organizations have sophisticated information systems that are capable of collecting, storing and analyzing certain types of sustainability information" (Frost et al., 2012, p. 224). This has also motivated researchers to study EMIS (Bansal & Roth, 2000; El-Gayar & Fritz, 2006; Walls et al., 2011), as a subfield of Green IS, which are "organizational-technical systems for systematically obtaining, processing, and making available relevant environmental information available in companies" (El-Gayar & Fritz, 2006, p. 768). Although EMIS are seen as enablers "for structured and goal-oriented data gathering, administration, integration, and processing" (Stindt et al., 2014, p. 2), most of the studies focus on system design and adoption rather than on the data as such. These studies include prototypes and investigations into EMIS implementation (Teuteberg & Straßenburg, 2009), as well as design principles for developing sustainable reporting or monitoring systems for emissions and energy usage (Hilpert et al., 2014; Zampou et al., 2022). They mainly identify EMIS components and functional features, such as supply chain coordination or reporting (Zampou et al., 2022), as well as information flows to combine various sources and calculate KPIs. Although Zampou et al. (2022) highlight the importance of considering data quality in the EMIS design, such as the data-cleansing process (e.g., to estimate missing product weights or volumes of product categories), existing EMIS literature has not further elaborated on data-related requirements or processes.

This reflects the current state of Green IS literature, which consistently reports that data-related problems are among the primary challenges that practitioners and researchers face (Marx Gómez & Teuteberg, 2015; Melville et al., 2017; Watson et al., 2010; Zampou et al., 2022). Several authors criticize the accessibility of data for sustainable development (Machado Ribeiro et al., 2022) and the unattended challenge "to gather all required sustainability data from external and internal sources" (Seethamraju & Frost, 2016, p. 3). The main data-related problems, identified in Green IS literature, are listed in Table 1. They include the unavailability of data or simply unknown data (Machado Ribeiro et al., 2022; Watson et al., 2010; Zampou et al., 2022), the lack of data integration and consolidation (Marx Gómez & Teuteberg, 2015; Zampou et al., 2022), and insufficient attention given to data quality and the underlying dimensions thereof, namely completeness and accuracy (Machado Ribeiro et al., 2022; Melville et al., 2017; Zampou et al., 2022). However, the existing studies do not go beyond stating the data-related problems nor do they elaborate on the specific data requirements or practices to address the issues.

**Table 1. Data-related Problems in Green IS Literature**

| Source | Context | Problem statements | Problem category |
|---|---|---|---|
| Watson et al. (2010) | Development of energy information systems targeted at analyzing and reducing energy consumption | "…the major issue is to design a sensor network that provides sufficient granularity to provide adequate data for an optimal solution" (Watson et al., 2010, p. 29)<br>"what data should be reported by an energy information system to inform governments' energy policies?" (Watson et al., 2010, p. 30) | Granularity of data<br>Unknown data |
| Marx Gómez & Teuteberg (2015) | Development and technical features of Corporate EMIS (CEMIS) | Lack of integration measures and a consolidation of various sources in an enterprise setting | Data integration and consolidation |
| Melville et al. (2017) | Systems that enable organizations to adopt low-carbon operations | Typical data quality dimensions, such as completeness and accuracy, are not sufficiently addressed | Data quality |
| Machado Ribeiro et al. (2022) | Literature review on data governance and sustainability | Importance of data governance mechanisms for sustainability, pointing toward the importance of data accessibility and data quality aspects | Data accessibility and data quality |
| Zampou et al. (2022) | Design theory for Energy and Carbon Management Systems | "…challenges in terms of, for example, data quality and availability, data capturing and integration, and information sharing" (Zampou et al., 2022, p. 6) | Data quality and availability, data capturing and integration, and information sharing |

As noted earlier, data is undeniably important to reliably report on sustainability initiatives and goals along the existing frameworks and regulations. To address the identified data-related problems, companies must understand the data requirements and develop dedicated processes to source the relevant data from internal and external parties; unfortunately, neither sustainability nor Green IS research has embraced these topics. For instance, if data sources' granularity is inadequate or is not consolidated before integration, the resulting data may be incomplete, inconsistent, or inaccurate, which can negatively impact the decisions based on this data. Thus, data needs to become an integral part of enterprise sustainability activities, and more research is needed on the data perspective in the context of sustainability. The increasing number of required data sources and their heterogeneity also call for the development of enterprise-wide data sourcing practices rather than ad-hoc sourcing.

# 3 Methodology

In view of our research goals, the present study employs institutional theory to explore the relevant pressures shaping sustainability initiatives and the subsequent organizational responses in the form of data sourcing practices. We leverage qualitative research methods, including focus groups and case studies, which are well suited to grasp the richness of specific situations in naturalistic settings (Benbasat et al., 1987; Van de Ven & Poole, 2005). Our research setting provided us with privileged access to data experts representing 12 multinational companies that have made SDG-related commitments and were in the process of refining their data sourcing practices. All companies are large multinational companies (or incumbents) from highly institutionalized industries (Powell & DiMaggio, 2012); they are characterized by a high level of regulation, standardization, and formalization that require their conformity and adherence to pressures. We closely collaborated with these companies in a multiyear research program studying data management practices for sustainability, subdivided into three research phases (see Table 2).

**Table 2. Research Process**

| Research phases | Phase 1: Exploratory research (05/2021 – 02/2022) | Phase 2: Five case studies (02/2022 – 04/2022) | Phase 3: Within- and cross-case analysis (04/2022 – 09/2022) |
|---|---|---|---|
| **Objectives** | • Explore sustainability reporting and the data-related challenges<br>• Identify the most relevant and tangible sustainability initiatives in the participating companies | • Gain an in-depth understanding of the ongoing sustainability initiatives in five selected companies<br>• Obtain insights into the data sourcing requirements, challenges, and emerging practices | • Analyze institutional pressures which influence the sustainability initiatives and the resulting data sourcing practices within and across the case studies<br>• Generalize and validate the results with experts |
| **Activities** | • Focus group 1 (5 participants from 5 companies): data challenges in the sustainability reporting process<br>• Focus group 2 (8 participants from 8 companies): scoping of the reporting goals<br>• Focus group 3 (17 participants from 12 companies): identification of sustainability initiatives | • Primary data: 60-minute individual, semi-structured interviews with 5 experts from 5 companies<br>• Secondary data: internal company documentation and presentations, corporate sustainability reports<br>• Prepare a write-up per case, comprising key statements and a process map of the data sourcing activities, and validate it with the experts | • Within-case analysis: coding of each case as a standalone entity based on a framework that builds on institutional theory<br>• Cross-case analysis: search for patterns across cases<br>• Focus group 4 (5 participants from 4 companies): consolidation of data sourcing practices<br>• Focus group 5 (10 participants from 8 companies): data model for data sourcing |
| **Outcomes** | • Problem scoping, list of 12 sustainability initiatives | • Five case write-ups and process maps | • Framework building on institutional theory, three sourcing practices |

### 3.1 Exploratory Phase

Our research activities began with an exploratory phase during the period of May 2021 to February 2022. We started with two focus groups involving 13 data management experts from 13 multinational companies with the aim of understanding the status of and issues in their sustainability reporting. This enabled us to identify key problem areas, among others, the ambiguous data requirements, ad-hoc data sourcing practices, and accompanying data quality-related issues. To narrow our scope, we subsequently conducted a third focus group with representatives of 12 multinational companies with the goal of identifying ongoing and concrete sustainability initiatives among the group (see Table 3). Although sustainability reporting remains an overarching driver, we found that many companies had also defined key sustainability initiatives and developed dedicated data sourcing practices to address them.

**Table 3. Companies Involved in the Research Process**

| Company | Industry | Revenue/employees | Key informants | Key sustainability initiatives |
|---|---|---|---|---|
| A* | Fashion and retail | $1B–50B/~60,000 | Director data governance | Product labeling |
| B* | Engineering and electronics | $1B–50B/~400,000 | Director master data management | Product ecological footprint |
| C* | Pharmaceutical, chemicals | $1B–$50B/~100 000 | Head of product data management | Product labeling |
| D* | Manufacturing, chemicals | $1B–$50B/~5,000 | Data steward material & product | Plastic packaging tax |
| E* | Consumer goods | $50B–$100B/~350,000 | Global master data lead | Packaging recyclability |

| | | | | |
|---|---|---|---|---|
| F | Adhesive & beauty products manufacturing | $1B–$50B/~20 000 | Director master data | Consumption of material in packaging |
| G | Manufacturing, chemicals | $1B–$50B/~20 000 | Head of data management | Sustainability reporting |
| H | Logistics | $1B–$50B/~70'000 | Program manager governance | ESG reporting, emission along the supply chain |
| I | Software development | $1B–$50B/~100 000 | Solution advisor expert | Reduction of workplace inequalities |
| H | Manufacturing, automotive | $1B–$50B/~90 000 | Senior data and analytics governance professional | Centralized sustainability reporting |
| J | Packaging, food processing | $1B–$50B/~25 000 | Enterprise data governance manager | Circular business models, advanced analytics |
| K | Manufacturing, automotive | $1B–$50B/~150 000 | Senior data architect | Supply chain emissions |

Notes:

All companies were involved in Phases 1 and 3

* indicates the companies involved in Phase 2

### 3.2 Case Selection

From February to April 2022, we immersed ourselves in the data sourcing practices of five of the 12 companies (see Table 4), thereby contributing to in-depth case studies. According to Benbasat et al. (1987), case studies are well suited to capture practitioners' knowledge and develop theories based thereon. Multiple case studies improve external validity while supporting analytical generalization (Yin, 2009). Although all 12 represent large, product-oriented, multinational companies from highly institutionalized industries that currently focus on sustainability goals and commitments, they had reached different levels of maturity in their data sourcing practices and ongoing sustainability initiatives. Using purposeful sampling, we selected the five most mature companies (of the 12) for further investigation. This maturity was reflected by the progress made in their sustainability initiatives and the supporting evidence for a systematic approach to sustainability reporting. Additionally, by selecting five companies representing different industries and positions in the value chain, we expected natural variation with regard to sustainability initiatives and related data sourcing practices, and to better determine the influence of environmental pressures.

Being active in the fashion and retail industry, Company *A* faces an increasing awareness of sustainability and fixed aggressive goals to increase the use of recycled materials. In their annual reports, *A* announced their commitment to end plastic waste, backed with strong objectives to reduce greenhouse gas emissions, use sustainable materials for their products, and ultimately achieve climate neutrality across the whole value chain. It introduced product labels (e.g., 100% recycled polyester) to better communicate its progress to consumers, but faced challenges in collecting the relevant information due to a high level of outsourcing to third-party suppliers in Asia.

Company *B*, representing the engineering and electronics industry, is actively engaged in improving the traceability of product-related emissions. With their objective to be honest and transparent in their sustainability reporting, *B* strives for comprehensible benchmarks and understandable metrics. To systematically collect and manage data on the ecological footprint of its materials and components, *B* is currently redefining the structure of its product master data in ERP systems.

Company *C*, in line with pharmaceutical and chemical industry requirements, engages in the transparent communication of product composition, particularly in terms of specific substances. Certain substances like heavy metals, which are necessary for chemical synthesis processes, demand careful consideration and pre-treatment to ensure they are properly managed before being discharged into wastewater. Being committed to sustainable use of resources and respecting planetary boundaries, *C* aims at obtaining certifications (e.g., Wildlife Habitat Council certification) and transparently communicating product composition through customer-facing third-party certification labels.

Company *D,* operating in the manufacturing and chemicals industry, embraced their path to becoming more sustainable, including reduction of emissions, responsible sourcing, use of recycled and bio-based materials, circularity, and reduction of waste. Among all, *D* also faces new regulations (e.g., the UK plastic

packaging tax) which impose penalties if the specified quantities of recycled plastic contained in packaging are not met. Thus, *D*'s main objective is to comply with emerging international regulations regarding packaging composition.

Finally, Company *E,* as one of the global players in the consumer goods industry, has set ambitious objectives in terms of waste reduction and protection of nature, namely with a significant reduction of plastic pollution. *E* attempts to meet increasing customer expectations by reducing the use of virgin plastic in different types of packaging. Consequently, *E* analyses the packaging's composition to improve its recyclability, specifically regarding its combined components.

### 3.3 Data Collection

We collected primary data by conducting semi-structured interviews with key informants – respectively representing each of the five companies (see Table A1 in the Appendix for the interviewee profiles) – between February and April 2022. We selected key informants who actively participate in the supervision and execution of data-related activities and the collection of data requirements in the ongoing sustainability initiatives. To observe incremental changes and capture the issues and challenges which accompany the implementation of sustainability initiatives, we ensured that the informants had significant tenure in their respective companies, as well as extensive experience in the field of data management. For each case, we conducted a one-hour interview per interviewee to garner insights about the company's sustainability initiatives, underlying data requirements, and emerging data sourcing practices. As an instrument of inquiry, our semi-structured interviews followed a nominal protocol that allowed us to ask questions related to the aims of the study (Castillo-Montoya, 2016) while simultaneously maintaining the fluidity and openness of the discussion with the interviewees. As part of the interviews, we jointly documented data sourcing activities together with the interviewees on a Miro board (collaborative digital whiteboard platform), starting from the core business processes, involved roles, required data objects, and encountered challenges. We then developed a first version of a process map for each company that included associated data objects and the relationships between them. After each interview, a write-up comprising key statements and the process maps for the documented initiatives were shared with the interviewee to confirm the correctness of the collected information and to clarify misunderstandings.

We complemented the interviews with an analysis of additional documents that we gathered throughout our research activities (e.g., slides shared during focus group presentations along with an overview of sustainability initiatives, the underlying process, involved applications, and data landscapes) and publicly available information (e.g., corporate sustainability reports of the respective companies that detailed their goals and progress in achieving them). By combining primary and secondary sources, we triangulated the collected data to ensure construct validity (Yin, 2009) and complemented the process maps with additional information about the company's sustainability goals and the context of the sustainability initiatives.

**Table 4. In-depth Case Studies (Focus on Product and Packaging)**

| Company | Institutional pressures | Sustainability goal and related SDGs | Sustainability initiative | Data sourcing challenges |
|---|---|---|---|---|
| A | Cultural-cognitive: increased competition due to the appearance of more visible products using recycled materials<br>Normative: increased customer demands for more sustainable products | Increase the use of recycled materials and better communicate the achieved progress to the end-consumers through self-declared product labels.<br>SDGs: 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 17 | Self-declared product labels | Inability to capture the data<br>Insufficient data to perform the calculations<br>Aggregating different units of measure |
| B | Normative: need for more professionalized approaches when communicating the ecological footprint of the products | Improve the traceability of the product-related emissions<br>SDGs: 2, 3, 6, 7, 8, 9, 11, 12, 13 | Product ecological footprint | Inability to capture the data<br>Unclear roles and responsibilities in data sourcing processes<br>Finding the right level of granularity for data aggregation |

| | | | | |
|---|---|---|---|---|
| C | Regulative: legal requirements to clearly label the products based on the used substances<br>Normative: moral obligations due to customer demands for clearer labeling | Obtain and clearly label the required product certifications<br>SDGs:1, 2, 3, 5, 6, 13, 15 | Third-party product labels | Difficulties in aggregating the data<br>Challenges faced when collecting the necessary data to comply with the certification requirements |
| D | Regulative: need to comply with plastic tax regulations in the concerned markets, e.g., UK plastic packaging tax | Comply with new regulations regarding the quantities of recycled plastic in the packaging<br>SDGs: 8, 12, 13 | Compliance with plastic packaging tax | Unclear how to deal with constantly changing regulations<br>Identify what the regulations consider as packaging (avoid possible confusion with the product itself) |
| E | Normative: increasing customer expectations regarding sustainable product packaging | Reduce the use of virgin plastic in the different types of packaging<br>SDGs: 9, 12, 13, 14, 15, 17 | Improve packaging recyclability | Lack of common definitions regarding what is considered recyclable<br>Unclear how to deal with multiple packaging components, particularly when different elements are combined |

### 3.4 Within- and Cross-Case Analyses

In the last phase of our research process, we analyzed the collected data, starting with the within-case analysis and then searching for patterns across the cases. For the within- and cross-case analyses, we used a research framework (see subsection 4.1), which we have developed by employing institutional theory to analyze and interpret our empirical insights.

We first investigated each case as a stand-alone entity and identified the causal links between institutional pressures and organizational responses in the form of sustainability initiatives and data sourcing practices. In line with our research objectives and to uncover the underlying conceptual logic of the collected case material (Miles et al., 2014), we analyzed each case based on the research model to identify for each case the relevant types of institutional pressures (regulative, cultural-cognitive, and normative), the prioritized sustainability initiatives, as well as data-related processes which companies go through in their reporting activities. As the process maps provide very rich data about the individual data sourcing practices, we inductively developed a coding scheme. Using visual mapping (Miles et al., 2014), we derived five key phases of the data sourcing process, namely planning, analyzing the relevant regulations and internal sustainability objectives, data collection and preparation, data integration, and finally reporting.

The within-case analysis provided a detailed understanding of the unique factors and context that influence the prioritization of sustainability initiatives, namely the motivations behind the engagement, documented in the activities of the planning phase within the process maps. These motivations were mapped with the institutional pressures from literature (see subsection 2.1), allowing for the proper documentation of the business context of the sustainability initiative, gathering insights into applicable regulations, and understanding the involved roles and responsibilities. We carefully analyzed the process maps in order to understand how each company performed the remaining activities – starting from collecting data from internal and external sources (including suppliers or other third parties), defining the gaps and assessing the usability of the data, defining target architecture, integrating data and aggregating it for further manipulations and calculations. By conducting iterative coding, and maintaining construct validity through peer debriefings, the within-case analysis provided a rigorous examination of the data sourcing practices of each company in the context of sustainability initiatives.

After comprehending the dynamics of each case, we analyzed cross-case patterns to gradually build a rich conceptualization, creating types or groups to compare and examine cases for shared configurations (Miles et al., 2014; Yin, 2009). We employed pattern matching to identify recurring themes across the cases, namely in terms of the exerted pressures and types of the initiatives (see section 4.2.1 – 4.3.2),

and the data sourcing practices. Based on the similarities and divergences in the five cases, we classified the initiatives along two dimensions, the scope (i.e., product and packaging) and the goal of the sustainability initiative (i.e., analyzing the ecological footprint and complying with regulatory requirements or labels). We compared the five cases with regard to the activities across the process phases and identified similarities as well as the differences, such as involved stakeholders, involved data objects, and necessary KPIs for reporting. The cross-case analysis of the process maps allowed us to identify three data sourcing practices that emerged in all cases, namely sense-making, data collection, and data reconciliation (see section 5).

In a final step, we discussed our findings in two focus groups with the larger group of companies. We used the first of these focus groups to validate the three identified data sourcing practices and generalize their characteristics. In the second focus group, we discussed our insights into the specific data requirements for product and packaging levels, which we documented in a conceptual data model.

# 4 Institutional Pressures, Sustainability Initiatives, and Data Sourcing

## 4.1 Research Framework

To explain how data sourcing practices develop in the context of sustainability, we employ institutional theory as a theoretical lens (see subsection 2.1) and developed a research framework (see Figure 1), which defined the a-priori constructs to analyze the cases. On its left-hand side, the framework posits that the three types of institutional pressures – regulative, normative, and cultural-cognitive – influence organizations engaging in sustainability initiatives (Galleli et al., 2021). On the right-hand side, the framework comprises the data sourcing practices which enterprises develop in response to the exerted institutional pressures to support the reporting on the sustainability initiative. As data sourcing practices have not been previously studied, we inductively derived the three data sourcing practices – sense-making, data collection, and data reconciliation – from the within and cross-case analyses.

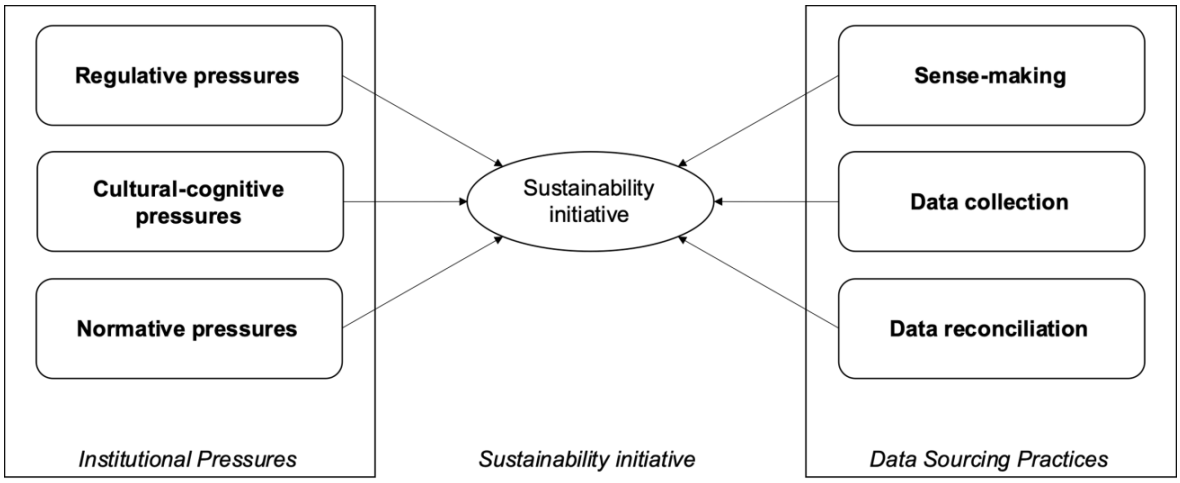


**Figure 1. Research Framework**

In the five selected cases, we analyze two types of sustainability initiatives which are representative of manufacturing companies, and which can either apply to the product or packaging level (see Table 5). The first type of initiative concerns the **ecological footprint** and requires an analysis of the materials that make up the product or its packaging. Based on the Bill of Material (BoM), involves identifying, examining, and understanding the composition on the lowest level of granularity. The second type of initiative goes a step further and aims at **obtaining labels** (voluntary) or **complying with regulations** (mandatory). These initiatives require an assessment of the material composition against the rules defined by regulations, product certification bodies (for a third-party label), or internally (for a self-defined label).

Based on the within- and cross-case analyses, we identify three categories of data sourcing practices that companies develop in their sustainability initiatives: sense-making, data collection, and data reconciliation. Due to the novelty of sustainability activities within the enterprises, **sense-making** involves a sophisticated analysis of the sustainability goals, ambitions, and regulations, as well as their interpretation

in terms of data requirements (Butler, 2011). During this phase, it is crucial to concretize and understand how to report on the sustainability initiatives to clarify the data requirements and identify the data objects and attributes which must be collected. It also requires a clarification of organizational matters, including the definition of roles and responsibilities to source the data. Based on these concretizations and clarifications, **data collection** can be initiated to obtain the data needed for sustainability initiatives. This data is often located within the existing operational systems (e.g., ERP or PLM systems), but it must be amended for the intended purpose of use. Due to value chain specialization and the specific data requirements thereof, some of the data has to be acquired externally (e.g., from suppliers or other parties). Finally, **data reconciliation** is necessary to prepare the data for further manipulations such as KPI calculations. This practice involves harmonizing the data obtained from different sources (with high variability of data types and formats) and aggregating it to the required level of granularity.

**Table 5. Sustainability Initiatives, Institutional Pressures, and Data Sourcing Practices**

| | **Type 1:**<br>**Analyze the ecological footprint** | **Type 2:**<br>**Obtain the label or comply with the regulation** |
|---|---|---|
| **Product level** | **Type 1a:** analyze the consumption of critical materials at the product level (Cases *A, B, C*)<br>**Institutional pressures:**<br>• ***Cultural-cognitive***: increased competition due to the appearance of more visible products using recycled materials<br>• ***Normative pressures***: growing demand for sustainable products<br>**Data sourcing practices:**<br>• ***Sense-making****:* understand the product composition (BoM) and materials at the lowest level of granularity<br>• ***Data collection***: identify missing data for finished products (BoM) and related materials; collect them from internal and external sources<br>• ***Data reconciliation***: harmonize and standardize material classifications and descriptions | **Type 2a:** obtain customer-facing, self-declared product labels (Case *A*) or obtain a third-party product certification label (Case *C*)<br>**Institutional pressures:**<br>• ***Regulative***: labeling requirements for product components/substances<br>• ***Cultural-cognitive***: intensified competition arising from prominent products offerings<br>• ***Normative***: moral obligations due to customer demands for clearer labeling and more sustainable products<br>**Data sourcing practices:**<br>• ***Sense-making***: understand the obtention conditions for the third-party or self-declared labels (e.g., the presence or absence of materials, thresholds)<br>• ***Data collection***: identify relevant data for label obtention within the finished product (BoM) and related materials<br>• ***Data reconciliation***: map material classifications and descriptions to label requirements; aggregate material data with different granularities to the product level |
| **Packaging level** | **Type 1b:** analyze the recyclability of the materials used in packaging (Cases *D*, *E*)<br>**Institutional pressures:**<br>• ***Normative***: growing customer expectations for sustainable packaging.<br>**Data sourcing practices:**<br>• ***Sense-making***: understand the packaging composition (BoM) at the lowest level of granularity<br>• ***Data collection***: identify missing data for packaging (BoM) and related material materials; collect them from internal and external sources<br>• ***Data reconciliation***: harmonize and standardize material classifications and descriptions | **Type 2b**: comply with the plastic packaging tax regulation (Case *D*)<br>**Institutional pressures:**<br>• ***Regulative***: need to comply with plastic tax regulations in the concerned markets<br>• ***Normative***: growing demand for sustainable product packaging<br>**Data sourcing practices:**<br>• ***Sense-making***: understand the limit set by plastic packaging tax (thresholds)<br>• ***Data collection***: identify relevant data for measurable thresholds and conditions within packaging (BoM) and related materials<br>• ***Data reconciliation***: map material classifications and descriptions and assess packaging composition against rules set by regulations |

## 4.2 Sustainability Initiatives and Data Sourcing Practices on the Product Level

### 4.2.1 Type 1a: Analyze the Ecological Footprint

Cultural-cognitive and normative pressures drive product-related sustainability initiatives in companies *A*, *B*, and *C* that seek to analyze their ecological footprint (see Figure 2). Although tough competition and the appearance of more visible products using recycled materials have motivated these companies to reevaluate their product offerings, increased customer demands for more sustainable products have taken their toll on them, leading to their reduced consumption of critical materials, such as plastics (to reduce their carbon footprint and to minimize environmental harm).

To analyze the ecologic footprint, *A*, *B*, and *C* first had to examine and understand product composition at the lowest level of granularity (*sense-making*). While this seems obvious, the companies had to go beyond their usual manufacturing perspectives and report on their actual use of specific materials in their final products. For each final product, this implies investigating the as-is BOM that lists all the components and materials that went into the product, having been procured from suppliers or manufactured in the company's own plant.

Second, to collect the necessary data, the companies assess and identify missing data for finished products and related materials and acquire the required data from internal and external sources. Interestingly, using available data to analyze the ecological footprint proved to be challenging, especially in the case of *A*. The reasons are a lack of required material classifications and that the product data was not previously analyzed within the ambit of the recycled materials used. In addition, data was often incomplete or not maintained within the enterprise due to increased levels of supplier outsourcing.

Once the data is collected, it must be harmonized and aggregated to calculate the percentage of specific materials at the level of the finished products. In this regard, companies do not only struggle to standardize material classifications and descriptions (e.g., external reference data GS1 for chemical substances), but also have to aggregate them when using different units of measures such as weight and surface. Reconciliation primarily prepares the ground for further manipulations of product data and provides clarity about the final product's ecological footprint in terms of individually used materials.

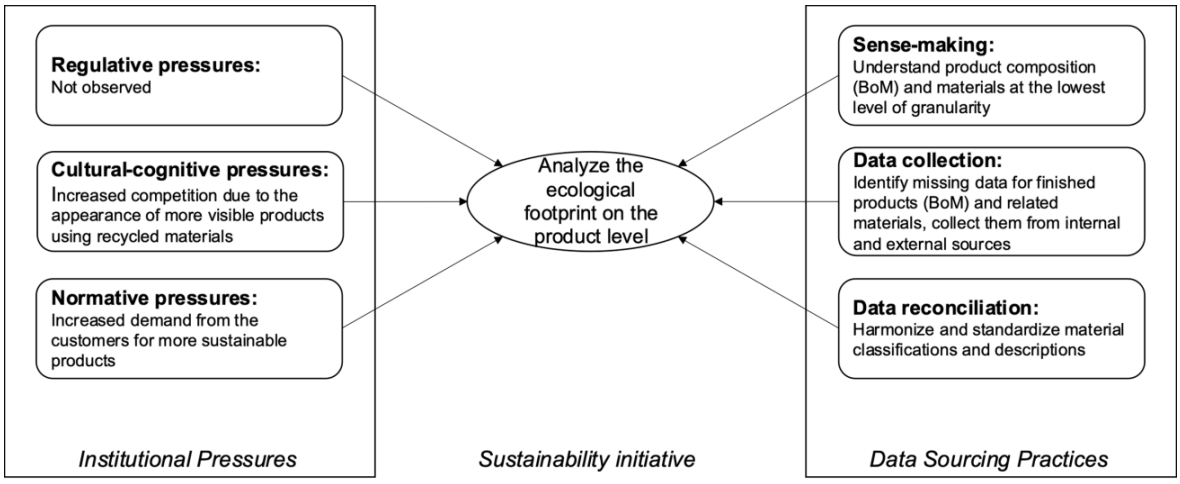


**Figure 2. Analyze the Ecological Footprint on the Product Level (Type 1a)**

### 4.2.2 Type 2a: Obtain a Product Label

The analysis of the ecological footprint is only the first step toward more ambitious sustainability initiatives with the aim of obtaining product certification labels (see Figure 3). As documented by cases *A* and *C*, all three institutional pressures – regulative, normative, and cultural-cognitive – impact the companies' practices. First, there are legal requirements to clearly label certain products, based on the used substances (e.g., in the pharmaceutical industry). Second, positioning labeled products is an important distinguishing aspect that allows companies to differentiate themselves from their competitors and to

secure price premiums. Third, companies have moral obligations toward their customers who demand clearer labeling and more sustainable products.

With this type of initiative, companies adapt their data sourcing practices by starting with sense-making of the obtention conditions for the third-party or self-declared labels. While there is no common way of specifying the conditions, they typically relate to the presence or absence of particular materials and define specific thresholds. Finding a suitable label also proves to be challenging since the obtention criteria require an interpretation of and alignment with the narratives that the companies intend to communicate about their products. In terms of data collection, they need to identify relevant data attributes for label obtention within the finished product (BoM) and related materials. Conclusively, for purposes of data reconciliation, *A* and *C* map material classifications and descriptions to label requirements, and aggregate material data with different granularities up to the product level. Since combinations lead to new requirements for a different product composition (e.g., in the pharmaceutical and chemical industry), it is noteworthy to consider the aggregations, which are done with multiple materials in a single product.

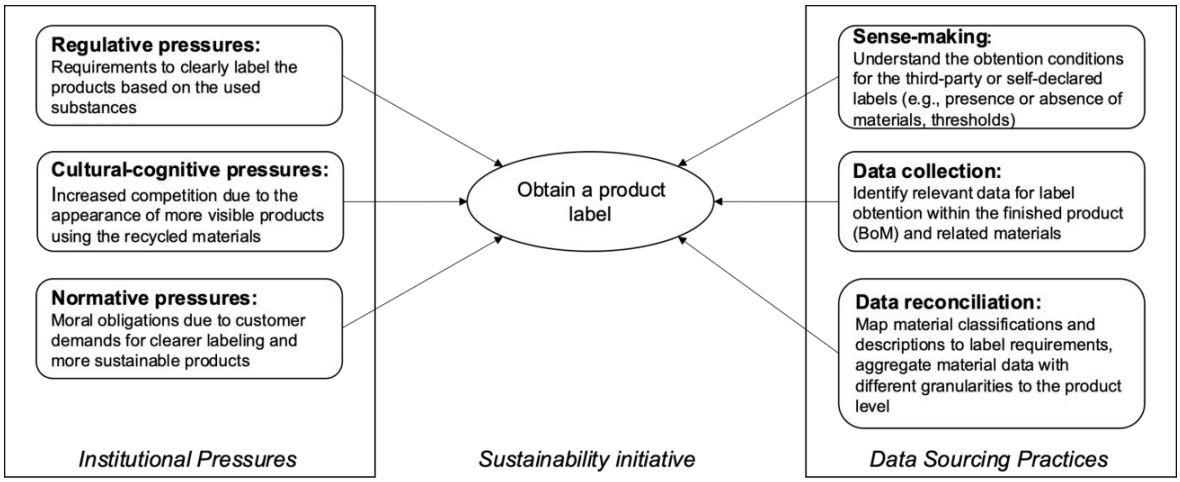


**Figure 3. Obtain a Product Label (Type 2a)**

### 4.3 Sustainability Initiatives and Data Sourcing Practices on Packaging Level

#### 4.3.1 Type 1b: Analyze the Ecological Footprint

With the intention of assessing the recyclability of the used packaging materials, cases *D* and *E* analyze the ecological footprint at the packaging level (see Figure 4). We found that the regulative and cultural-cognitive pressures do not play a significant role in this initiative, although they increase the all-important customer expectations regarding sustainable product packaging (i.e., normative pressures).

In terms of sourcing practices, we found that – like the product level – understanding packaging composition (BoM) at the lowest level of granularity is not a trivial matter and requires sense-making. For instance, with different types of packaging, *D* and *E* convey the importance of setting a clear scope for the analysis, such as retail packaging, unit packaging, or packaging for protection during transportation. Relevant data must be collected to perform these analyses, starting with the identification of missing data for the packaging (BoM) and related materials which, in turn, is collected from internal and external sources. Material classifications and descriptions for the used packaging must be harmonized and standardized to perform the necessary calculations depicting the composition of the packaging. Company *E* highlights the importance and difficulties of the correct aggregation since packaging types often tend to combine multiple components, some of which are entirely non-recyclable. *E*'s global master data lead states that, "a product can go through different states of packaging, from unit-level to pallet aggregation, which is a challenge from the data management perspective." This potentially leads to packaging confusion as a whole, especially when a material combination makes the entire packaging non-recyclable.

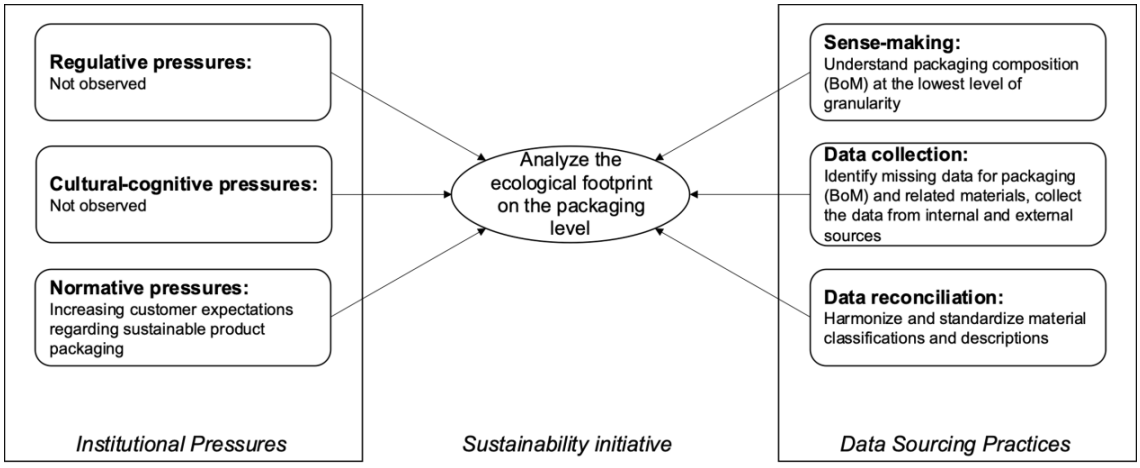


**Figure 4. Analyze the Ecological Footprint on the Packaging Level (Type 1b)**

### 4.3.2 Type 2b: Comply with Regulations

Building on the obtained understanding of the packaging's composition, companies can engage in additional initiatives. Case *D*'s objective is to comply with emerging regulations that specify acceptable thresholds of recycled plastic in the packaging (see Figure 5). Evidently, the regulative pressure and emerging regulatory requirements compel companies to comply with and engage in such initiatives. These not only encompass country-specific requirements concerning the consumption of manufactured single-use items (Italy) and the proportions of recycled plastic in a packaging component (UK), but also the companies' own initiatives. Furthermore, similar to the previous initiatives, cultural-cognitive pressures in the form of customer expectations influence company practices.

With this type of initiative, we observed a set of data sourcing practices. First, it is necessary to understand the limits set by the plastic packaging tax (e.g., in terms of the threshold for the presence of recycled plastics in the packaging) and by the incumbent tax rates. Consequently, it is necessary to distinguish between the packaging itself and the individual components which are used for the packaging (e.g., adhesive, liner, core, and backing). To illustrate, in the case of *E,* this was of particular importance since the individual packaging components are also deemed to be products, thus complicating compliance and requiring an adaption of the components' unit of analysis. Second, it is, therefore, necessary to identify relevant data for measurable thresholds and conditions within packaging (BoM) and related materials. Third, in terms of data reconciliation, material classification, and descriptions must be mapped, along with an assessment of the product's packaging composition against the rules set by the regulations.

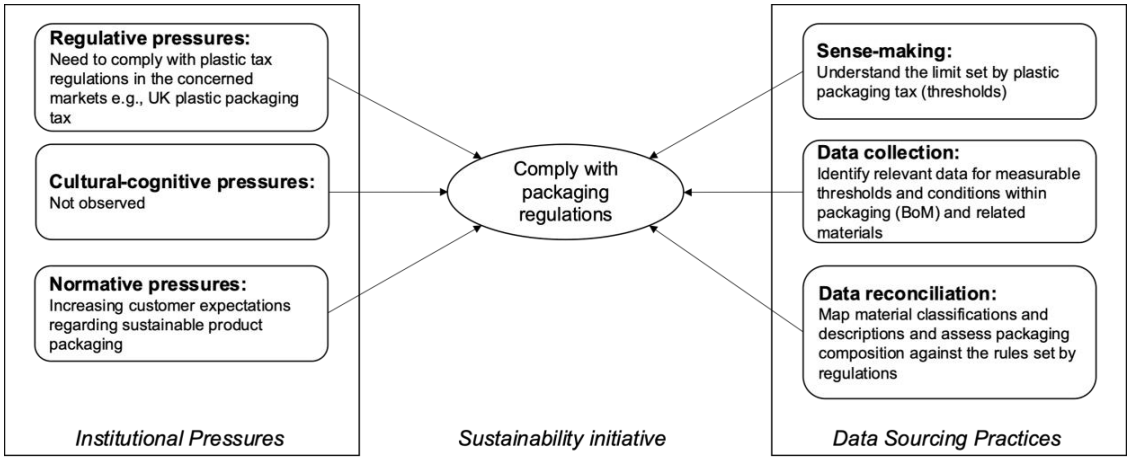


**Figure 5. Comply with Packaging Regulations (Type 2b)**

# 5 Data Sourcing Practices for Sustainability

Based on our empirical findings, we identify three categories of data sourcing practices that we discuss in more detail with reference to their activities, outcomes, roles, and responsibilities, and associated challenges (see Table 6).

**Table 6. Data Sourcing Practices for Sustainability**

| Data sourcing practices | Sense-making | Data collection | Data reconciliation |
|---|---|---|---|
| **Activities** | Analyze and interpret the sustainability goals, ambitions, and regulations<br>Translate them into tangible data requirements and identify the relevant data objects and attributes<br>Decide on the approach to data collection and processing | Analyze available data needed to implement the sustainability initiatives<br>Assess quality and identify gaps<br>Collect missing data from internal and external sources | Harmonize the definitions and map internal with external reference data.<br>Prepare and aggregate the data for further manipulations and calculations |
| **Outcomes** | Relevant data objects and attributes for the sustainability initiative | Quality assessment and gaps in existing data; collection of missing data objects and attributes from internal and external sources | Curated database for KPIs and sustainability reporting |
| **Roles and responsibilities** | Sustainability officer, compliance officer, business analyst (sustainability report owner) | Data steward, data analyst, business operations | Data steward, data engineer |
| **Challenges** | • Difficulties in adapting to an increasing number of regulations and certifications that address the same SDGs<br>• Interpreting and translating the sustainability goals, legal texts, or certification label requirements into concrete data objects and attributes | • Inability to capture the necessary data along a global supply chain<br>• Missing or erroneous data (e.g., material description) which is presumed to be complete in the enterprise systems | • Heterogeneity of data sources (e.g., variability of types and formats between data from internal and external sources)<br>• Lack of definitions and semantics, as well as difficulties encountered when mapping against them (e.g., recycled material) |

**Sense-making**: This practice involves the time-consuming analysis of the sustainability goals, ambitions, and regulations and their interpretation in terms of data requirements. In initiatives where regulatory pressure is exerted, cross-functional teams – with sustainability, legal, and data expertise – must interpret the legal texts or lengthy certification contracts and translate them into tangible data requirements. In these instances, sense-making clarifies the data objects and attributes mentioned in the regulation – including a rough understanding of their semantics – which should be collected in the next data sourcing phase. In initiatives that were not a response to regulative pressures, but initiated by internal data management efforts, sense-making relates to translating ambitious sustainability goals and indicating how to measure them. The sense-making activities mainly focus on defining suitable measurement rules and understanding the data at hand, that is, identifying relevant data objects and attributes that are already in the systems, as well as discovering gaps that must be filled to address the goals set by the sustainability initiatives. This implies that without exerted regulative pressures, enterprises pursue self-set goals and ambitions, being driven by the other two types of pressure.

**Data collection:** This practice involves the analysis of available data needed to realize sustainability initiatives, quality assessment, and gap identification, as well as the collection of missing data from internal and external sources. We notice that the four sustainability initiatives mainly build on existing, well-defined data objects as input, which are repurposed for sustainability needs. For instance, *product master data* for the finished products, *material master data* for all parts, components, and raw materials, and the *BoM* are essential to gain an understanding of the composition of a finished product or its packaging at the lowest level of granularity. By contrast, there are new data objects which previously have not been maintained in companies' systems, and which must be created. These objects, among others, include specific KPIs (e.g., *plastic indicator)*, as well as relevant meta information (e.g., *product label*,

*certification body*, *regulation)*. Even though several data objects already exist in companies' ERP and BI systems, sustainability activities repurpose and extend the scope of the data use (e.g., with amendments to the material descriptions and classifications) and, in turn, require the establishment of new business rules and data pipelines. Furthermore, sustainability initiatives often rely on external data that can only be collected from business partners or in terms of applicable industry benchmarks for environmental sustainability (e.g., SDG Ambition (SAP, 2020)). Based on the insights gained from the cases, we noted that the four initiatives rely on similar data objects and attributes, and we validated this learning in focus group sessions. We, therefore, decided to consolidate the data requirements in the form of a conceptual data model that supports sense-making, data collection, and data reconciliation practices. This model conceptualizes the data requirements with reference to ten relevant data objects and attributes of the identified sustainability initiatives (see Figure 6). A mutual understanding of these attributes prepares the ground for a common view of the initiatives' data requirements (see Table A2 in Appendix B).

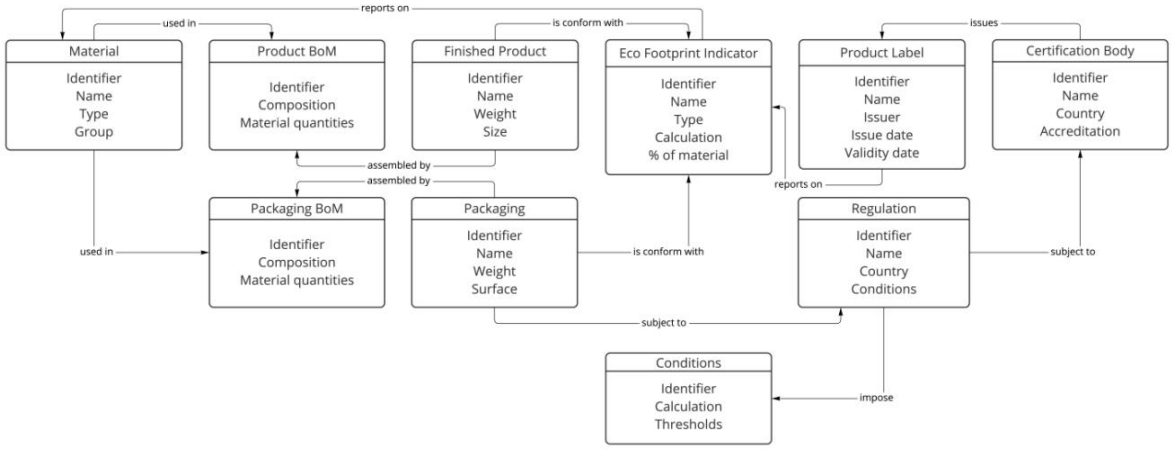


**Figure 6. Data Requirements for Sustainability Initiatives at Product and Packaging Level**

**Data reconciliation**: This third data sourcing practice encapsulates activities that prepare the data for sustainability reporting and harmonize data from different sources. For instance, to calculate the KPIs on the use of recycled material in a given product, internally and externally collected heterogeneous data should be brought together. Companies struggle with the variability of the sourced data's types and formats, which complicates aggregation. For example, *A* faced difficulties in aggregating the data on components into the final product's composition due to the different units of measurement (e.g., the surface and weight of the product). Finally, the required harmonization across heterogeneous data sources and the lack of definitions and semantics that cause difficulties in their use are among the most demanding challenges faced by companies.

# 6 Discussion, Implications, and Future Action

## 6.1 Summary of Contributions and Discussion

Our study is an example of impact-oriented Green IS research (Gholami et al., 2016) that guides enterprises on their way to becoming more sustainable, while embedding sustainability in IS and in practice (Seidel et al., 2017). More specifically, our findings advance Green IS and EMIS literature that has, in the past, mainly identified issues concerning data quality and accessibility (Machado Ribeiro et al., 2022; Melville et al., 2017; Zampou et al., 2022) without elaborating further on the data as such. To address this gap, our study introduces a data perspective on sustainability and draws attention to data sourcing practices as a basis for reliable and trustworthy sustainability reporting. It makes a two-fold contribution. First, as a theoretical contribution, we propose institutional theory as a suitable lens to uncover how data sourcing practices are shaped in response to exerted external pressures. The resulting research framework allows for the identification of causal chains, leading from the relevant pressures to prioritized sustainability initiatives, and the emerging data sourcing practices. Second, our empirical contributions include novel, revelatory insights into key initiatives in the field of environmental sustainability, that touch on first, understanding the ecological footprint, and second, obtaining labels or complying with regulations, both on product and packaging levels. From our cross-case analysis, we

derive three general data sourcing practices to address the data-related issues in sustainability initiatives: sense-making, data collection, and reconciliation. To support these three practices, we outline a conceptual data model that synthesizes the relevant data objects and attributes that need to be sourced for product-and packaging-related sustainability initiatives.

Our findings not only highlight three general data sourcing practices, but also help to understand – via the lens of institutional theory – how the exerted pressures shape those practices: interestingly, the normative and cognitive-cultural pressures were as prominent, if not more so, than the regulative pressures in shaping the data sourcing practices. While firms of course gain and maintain legitimacy through attempting to navigate the complex regulations that have already emerged (Scott, 2013), we saw that the pressure from other organizations (Aldrich, 1979; DiMaggio & Powell, 1983) and customers played a substantial role in prioritizing sustainability initiatives and their data requirements. The context of sustainability transcends its regulative implications, where companies must vie for "political power, institutional legitimacy... as well as economic fitness" (DiMaggio & Powell 1983, p. 150) from its peers, competitors, and customer constituents alike. Here we see that seeking legitimacy by conformity is not a static property, achieved only by creating data sourcing practices to simply comply with regulations and rules, but it seems to be instead a more dynamic process socially constructed by the companies (and regulators) (Burdon & Sorour, 2020; Suddaby et al., 2017). This implies that companies will continue to adjust and move forward with the three data sourcing practices that have thus far emerged as reactions to the emerging institutional pressures.

The three data sourcing practices are a prerequisite for reliable and trustworthy sustainability reporting, thereby avoiding or mitigating the risks of greenwashing (Szabo & Webster, 2021). Interestingly, our findings also highlight that data sourcing for sustainability reporting is inherently more complex than for traditional reporting. In financial reporting, companies rely on established accounting standards and most of the data is generated internally and managed by accounting teams, whereas, in the sustainability context, the requirements and responsibilities are yet to be clearly defined. Therefore, the sense-making derived from internal goals or regulations is an essential step in translating the high-level requirements from regulations or internal ambitions into concrete data requirements and identifying data that should be sourced along the entire supply chain. Our study also reveals that data sourcing practices for sustainability rely on cross-functional collaboration between multiple stakeholders: sustainability and compliance officers as well as business analysts for sense-making; data stewards, data analysts, and business operations for data collection; and data stewards and data engineers for data reconciliation. The collaboration even goes beyond the internal stakeholders to embrace external parties, most importantly suppliers, logistics providers, and other partners along the entire supply chain. Another characteristic of data sourcing for sustainability is that data must be repurposed (e.g., product or packaging dimensions), or even created on demand (e.g., prescribing the weight of recycled materials in a product). Thus, more heterogeneous data is collected from various (internal and external) sources, which must be integrated with internal systems and adapted for the new data and business requirements. This underpins that data reconciliation requires companies to develop integration and data management strategies that ensure seamless information flows and effective analytics.

### 6.2 Implications for Research

Our research complements Green IS research, which has largely focused on EMIS design, in terms of components, features, and design principles. It suggests adding a dedicated data perspective to this stream of research in order to address the data-related issues that have been highlighted in prior Green IS studies (Marx Gómez & Teuteberg, 2015; Melville et al., 2017; Zampou et al., 2022). Our findings highlight that reporting on sustainability initiatives is not uniform across companies, but shaped in response to external pressures and goes hand in hand with the development of data sourcing practices. The identified practices come with challenges at different levels, which also represent interesting opportunities for future research – from the interpretation of sustainability-related regulations using formal or semi-formal approaches (sense-making) to the platforms supporting the gathering of data along global supply chains (data collection), and the definition of semantic data models in the form of knowledge graphs for sustainability-relevant information that allow the efficient integration and aggregation of the data of heterogeneous formats and granularity (data reconciliation). While our study suggests ways to address the data-related issues that have been highlighted in prior Green IS studies (Marx Gómez & Teuteberg, 2015; Melville et al., 2017; Zampou et al., 2022), it also reveals that sustainability reporting becomes increasingly integrated into traditional corporate reporting. Thus, Green IS and EMIS researchers should study the disclosure requirements imposed by existing and emerging reporting regulations, such as

CSRD, and investigate EMIS in the context of corporate reporting processes and platforms. The suggested research model can serve as a framework to theorize about CSRD as well as other industry- or country-specific sustainability regulations, their impact on sustainability initiatives, and the development of data sourcing practices. It allows for the identification of patterns among different business contexts and settings and analyzes the context-specificity of reporting requirements and data sourcing practices.

Our research also contributes to and has implications for the emerging body of research on data sourcing which extends prevailing IS/IT sourcing concepts by considering data as a specific object of sourcing (Jarvenpaa & Markus, 2020; Krasikov et al., 2022). Given the relevance of data sourcing in the context of sustainability, we call on the IS community to utilize this opportunity to further explore data sourcing practices "to reach an eventual symbiosis in which research informs practice and practice informs research" (Seidel et al., 2017, p. 42). Future research could use these findings to develop a holistic data sourcing theory in the context of enterprise-wide sustainability activities. We also see opportunities for academic research that explores how established data management principles and concepts complement data sourcing practices. Finally, the intersection of data sourcing and sustainability undeniably provides exciting opportunities for further inquiries into sustainable supply chains, Green IS, and sustainable computing, and for the continued examination of EMIS.

### 6.3 Implications for Practice

Systematic data sourcing practices enable enterprises to accurately and transparently report on the progress of their sustainability initiatives. They not only support compliance with the existing and upcoming reporting regulations, such as the European CSRD, but also help build trust with key stakeholders, most importantly their customers, and enhance the enterprise's reputation. For practitioners, our findings support companies that intend to go beyond ad-hoc approaches when fulfilling sustainability requirements and develop systematic data sourcing practices as a basis for reliable and trustworthy sustainability reporting. As the identified sustainability initiatives are of high relevance for many companies, practitioners can use the conceptual data model to identify typical data requirements for environmental sustainability and leverage the data sourcing practices as a basis for setting up their internal data sourcing processes. Firstly, sense-making is an essential first step in translating regulations or internal goals and ambitions into concrete data requirements. Secondly, data collection focuses on identifying and gathering data (also data that has never been collected before), within and beyond the organizational boundaries, requiring external data from suppliers and other business partners. Thirdly, the reconciliation of heterogeneous sources is a challenging integration endeavor, which needs to be supported by shared semantics (i.e., ontologies) and standards.

Our study highlights that even though enterprises are active in diverse industries and business contexts, reporting on environmental sustainability still requires them to report on the same data objects which are maintained in their ERP systems. Practitioners can use the conceptual data model to map data objects and attributes in these systems, to assess the need for enrichment from internal and external sources, and to define the target data model to reconcile data collected from heterogeneous sources.

### 6.4 Limitations and Outlook

Like most research, this study is not without limitations. First, it builds on empirical insights gleaned from the selected cases drawn from a larger pool of companies. While the identified challenges and practices are relevant for product- and packaging-related initiatives, they may not be generalizable to other contexts. Although we discussed the data sourcing challenges and practices in focus groups involving a larger group of companies that also prioritize other initiatives, our findings are limited to the scope of environmental sustainability initiatives. It would be interesting to replicate our study with initiatives in the fields of social and economic sustainability, thereby enlarging its generalization potential. Second, given that many companies are still in the early phases of their sustainability initiatives and that multiple regulations are expected to be rolled out in the future, there are opportunities for longitudinal studies that analyze the evolution of institutional pressures and data sourcing practices. Third, and from a theoretical perspective, institutional theory offers valuable insights into the influence of external pressures on organizations' behavior and decision-making processes, but it also has limitations. For instance, while it recognizes the importance of legitimacy, institutional theory may not fully account for ethical considerations related to data sourcing practices. Organizations may face conflicting pressures between achieving legitimacy and adhering to ethical principles, particularly in the context of sustainability. The theory's emphasis on conformity and legitimacy-seeking behavior may overshadow the ethical dimensions of data sourcing decisions. Furthermore, the theory often assumes a certain level of homogeneity in how

organizations respond to external pressures, assuming conformity and isomorphism. This opens an interesting avenue for future research, namely observing the variation and diversity among organizations in their data sourcing strategies.

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# Appendix A: Interviewee Profiles

**Table A1. Interviewee Profiles**

| Company | Job title | Years of experience | Interview duration | Industry | Company's revenue / employees | Key sustainability initiatives |
|---|---|---|---|---|---|---|
| A | Director data governance | 19 years (7 years in company A) | 78 minutes | Fashion and retail | $1B–50B / ~60,000 | Product labeling |
| B | Director master data management | 15 years (11 years in company B) | 75 minutes | Engineering and electronics | $1B–50B / ~400,000 | Product ecological footprint |
| C | Head of product data management | 20 years (20 years in company C) | 63 minutes | Pharmaceutical, chemicals | $1B–$50B / ~100 000 | Product labeling |
| D | Data steward material & product | 10 years (3 years in company D) | 59 minutes | Manufacturing, chemicals | $1B–$50B / ~5,000 | Plastic packaging tax |
| E | Global master data lead | 27 years (16 years in company E) | 58 minutes | Consumer goods | $50B–$100B / ~350,000 | Packaging recyclability |

# Appendix B: Definitions of Attributes

**Table A2. List of Definitions of the Attributes**

| Data object | Attribute | Definition |
|---|---|---|
| Material | Identifier | A unique identifier assigned to the material |
| | Name | States the name assigned to the material and defines the material |
| | Type | Specifies material categorized together and defines the available views on the material |
| | Group | Classifies a group of materials with similar attributes and specifies the use of this group |
| Product BoM | Identifier | A unique identifier assigned to the product's bill of material |
| | Composition | Specifies the materials used to manufacture the product |
| | Material quantities | Specifies the quantities of used materials |
| Packaging BoM | Identifier | A unique identifier assigned to the packaging's bill of material |
| | Composition | Specifies the materials used in the manufactured packaging |
| | Material quantities | Specifies the quantities of used materials |
| Finished Product | Identifier | A unique identifier assigned to the product |
| | Name | States the name assigned to the finished product and defines the product |
| | Weight | Specifies the finished product's weight |
| | Size | Specifies the finished product's size |
| Packaging | Identifier | A unique identifier assigned to the packaging |
| | Name | States the name assigned to the packaging and defines the packaging |
| | Weight | Specifies the packaging's weight |
| | Surface | Specifies the packaging's surface |
| Eco-footprint indicator | Identifier | A unique identifier assigned to the ecological footprint indicator |
| | Name | States the name assigned to the indicator and defines the indicator |
| | Type | Specifies indicators categorized together and defines the available views on the indicator |
| | Calculation | Defines the calculation rules for the indicator |
| | % of material | Specifies the quantities of materials used in the calculation |
| Product Label | Identifier | A unique identifier assigned to the product label |
| | Name | States the name assigned to the product label and defines the product label |
| | Issuer | Name of the issuing organization for the product label |
| | Issue date | Date on which the product label was issued |
| | Validity date | Date until which the product label is valid |
| Certification Body | Identifier | A unique identifier assigned to the certification body |
| | Name | States the name of the certification body |
| | Country | The country in which the certification body is located |
| | Accreditation | Confirms the competence of the certification body according to internationally recognized standards |
| Regulation | Identifier | A unique identifier assigned to the regulation |
| | Name | States the name assigned to the regulation and defines the regulation |
| | Country | The country (or countries) in which the regulation is applicable |
| | Condition | Conditions imposed by the underlying regulations |
| Condition | Identifier | A unique identifier assigned to the condition |
| | Calculation | Defines the calculation rules for the required compliance regulation |
| | Thresholds | Defined thresholds in accordance with the regulatory requirements |

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